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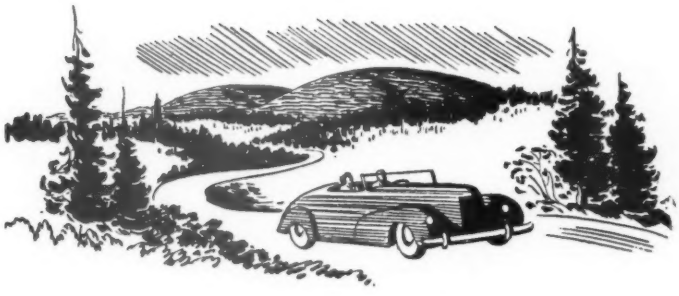


There'll come a day

When you get home to the West, Joe Soldier, you'll find waiting friends unchanged. There are the mountains. And the forests. And trout streams bustling grumpily among smooth rocks—just as you remember.

And the roads. The roads that bring you to remembered places are still there. You'll drive them again—with the wind in your face and peace in your heart. For, somehow or other, the highway people are managing to keep the roads in shape.

How they do it, they alone know. There's a growing belief they pull rabbits out of hats—and set them to work. Be that as it may, the highway commissions, engineers, and crews—right down to the last man and his shovel—*are* keeping the roads abreast their war-job.

From the Columbia to the Colorado, the big trucks roll night and day. Across the desert and beside the ocean, Joe, men and material move unceasingly—in unbelievable masses. The traffic is vital—strictly industrial and military. And it's heavy.

Yes, sir, the roads take a beating. If Uncle Sam had an award for things-wounded-in-line-of-duty, they'd rate an Asphalt Heart with silver chuckholes. Yet the highway people keep them hale. While you tramp the road to Berlin or Tokio, Joe, or maybe Mandalay, they see that the home roads back you up. They, too, deserve a medal.

Those roads will carry you again among everlasting mountains that mean home, beside everlasting streams that war only with smooth rocks—on tires that sing a song of everlasting freedom in the soul!

STANDARD OF CALIFORNIA

E flag, with 3 stars, awarded to our Richmond Refinery

The Course of Oil

K. C. SCLATER

REVISED AGREEMENT SUBMITTED

In compliance with the request of Petroleum Administrator for War Ickes that the industry make known in *specific language* how the Anglo-American oil agreement might be revised, the Petroleum Industry War Council has just submitted a revised oil agreement. This revision puts the oil industry of the United States squarely on record regarding what it considers should be the basis for a foreign oil policy.

The Board of Directors of the American Petroleum Institute has also recommended to the Petroleum Administrator for War that the suggested revision of the oil agreement presented to the Petroleum Industry War Council by its National Oil Policy Committee be substituted for the original oil agreement. In support of this recommendation, it is suggested that a consistent foreign oil policy should be established and maintained "by giving necessary and legitimate diplomatic support, under the principles of international law, to its nationals engaged in foreign oil operations; by fostering the private enterprise of its nationals in foreign exploration, production, transportation, refining and marketing of petroleum and its products; by the establishing as a cardinal principle in such foreign oil policy of the Government of the United States that the Government itself will not directly or indirectly engage in foreign oil ownership, exploration, development, or operation, either in its sovereign or proprietary capacity, or through the media of ownership in corporations or other agencies engaged in the petroleum industry; by creating an international instrument of consultation and collaboration, without power of enforcement and in which there is joint government-industry representation, as essential to further world oil development on a basis of mutual respect."

In the revised agreement submitted by PIWC the purpose and scope are clearly outlined. Many of the objections cited by the oil industry to the original agreement have been removed. No positive mention is made, however, regarding representation of the petroleum industry on the International Petroleum Commission, other than the statement that "to enable the Commission to maintain close contact with the operations of the petroleum industry, each Government will provide for full and adequate consultation with its nationals engaged in the domestic petroleum industry as well as with those engaged in the international petroleum trade."

The revised draft of the agreement makes clear in its provisions that the International Petroleum Commission be set up as a consultative and advisory body. It assumes voluntary action, based on mutual understanding and benefit, rather than compulsory action, on the part of the signatory governments. For example, it provides that "unless the signatory governments decide otherwise in any particular case, all reports of the International Petroleum Commission shall be promptly published by each Government. Upon such publication by a Government, any action taken in compliance therewith shall not be deemed an infringement of its laws with reference to restraints of trade," and also that "no provision in this Agreement shall be construed to require a signatory Government to act upon any report or suggestion made by the Commission, or to require the nationals of a signatory Government to comply with any report or suggestion made by the Commission, whether or not it is published."

Regarding interference with the domestic industry within any country it is stated that "no provision in this Agreement shall be construed to apply to the operation of the domestic petroleum industry within either country," and that, "no provision in this Agreement shall be construed to prevent a signatory Government from taking such action as it may desire to limit the amount of petroleum which may be imported into its country." Thus each country would be free to run its own domestic oil industry without interference on the part of the International Petroleum Commission. Further, "in making supplies of petroleum thus accessible in international trade the interests of producing countries should be safeguarded with a view to their economic advancement."

Most important and clear-cut are the provisions outlining the duties and responsibilities of the International Petroleum Commission with respect to international petroleum trade. These are: "to initiate studies of the problems of the international petroleum trade caused by dislocations resulting from war; to initiate studies with respect to past and current trends in the international petroleum trade; to initiate studies of the effects of changing technology in the petroleum industry upon the international petroleum trade."

The duties and responsibilities of the International Petroleum Commission as provided for in the revised draft of the agreement parallel to some extent those of our own Interstate Oil Compact Commission.

The revised draft of the agreement is now in the hands of Mr. Ickes and the State Department. Its full and impartial consideration by the Governments of this country and Britain will, it is hoped, result in an international agreement that will lay the basis for a healthy, prosperous, international oil industry founded on free and fair competition.

Long run proves plant

THE world's smallest commercial fluid catalyst cracking unit has made good in its initial run on synthetic catalyst, which went 65 days without a stop

It is a part of the Frontier Refining Company's new aviation gasoline refinery in Cheyenne, Wyoming

During the run the plant produced its quota of aviation gasoline, fully meeting the rigid specifications of the Army and Navy

The starting date was May 30 On August 3 the plant was shut down for inspection It was in good condition and could have run longer This unit is now on its second successful run

Universal designed the facilities in the Frontier refinery, which is one of the scores of U. O. P.-designed war plants that are contributing substantially to the aviation gasoline supply—or are nearing completion

CATALYTIC CRACKING	HYDROFORMING
CATALYTIC REFORMING	DEHYDROGENATION
HYDROGENATION	POLYMERIZATION
ALKYLATION	RETREATING
ISOMERIZATION	POLYTREATING
THERMAL CRACKING	U. O. P. CATALYSTS
THERMAL REFORMING	UNISOL TREATING

U. O. P. INHIBITORS

GASOLINE POWERS THE ATTACK — DON'T WASTE A DROP

Universal Oil Products Co.
Chicago 4, Ill., U. S. A.

UOP

Petroleum Process Pioneers
For All Refiners

The Refiners Institute of Petroleum Technology

National Petroleum Situation

MORE DRILLING, POORER RESULTS. A sharp increase in drilling in November increased well completions 123 above October, but productive oil wells were 78 less than October. The net effect was 173 more dry holes than October and a substantial increase in the dry hole ratio. The lag in wildcatting continued in November with the result that drilling in the first 11 months is 7 per cent below expectancy.

NEW PRODUCTION PEAK. Crude production reached a new peak in November of 4,755,000 barrels daily. Gains were reported by California, Oklahoma, Louisiana, New Mexico, Mississippi and Illinois. Output this year is 12 per cent above a year ago. Texas production increased 27 per cent above last year. National production this year has been about 2 per cent under actual requirements.

HIGH MOTOR FUEL OUTPUT. Continued stepping up of motor fuel production has enabled the industry to exceed requirements in the first 11 months of this year by about 2,500,000 barrels. An important factor is the greater recovery of gasoline from crude by refineries. November yield was the highest in many months, averaging 40.7 per cent, against 38.7 per cent a year ago. This year's increase is 2.2 per cent in gasoline recovery, which means about 33 million barrels more motor fuel than might have been produced on basis of last year's yield.

NATURALS CONTINUE GAIN. The vital part natural gasolines are playing in war demand for motor and aviation fuels is apparent by continually greater production of these products in response to growing war needs. Since Pearl Harbor the production of natural gasoline has nearly doubled and in the past 11 months output has increased more than 10 million barrels over last year. Increased production of naturals in combination with more crude processing at higher yields have boosted production of motor fuels 125 million barrels or 22 per cent over last year.

STOCKS SUB-NORMAL. Crude stocks are now 52 million barrels below normal needs whereas stocks of all refined products are 48 million barrels too low. The industry should normally have a 60-day supply of crude and products in storage and in lines. Unusual requirements for war, however, do not permit seasonal stock build-ups, but the facts indicate that today's working stocks in relationship to the all-time peak requirements for crude and products are subnormal to the extent of about 17 per cent.

STILL RUNS UP 221 MILLION BARRELS. Runs of crude to refinery stills in the first 11 months of this year showed an increase of 221 million barrels over last year. This was an increase of 17 per cent. Particularly significant is the fact that the increase in refining operations exceeded the national increase in crude production to the tune of 76 million barrels. Domestic crude production during the same period increased 165 million barrels over last year.

Comparative Statistics, November, 1944

*All figures are computed on a Bureau of Mines basis.**

	Nov. 1944(p)	October 1944(p)	Nov. 1943	This year to date	Last year to date	Per cent change
Wells drilling	4,300	4,200	2,903	4,300	2,903	+48
Total wells drilled	2,225	2,102	1,732	20,389	16,176	+26
Development wells	1,894	1,757	1,429	16,878	13,127	+29
Oil	1,134	1,205	920	11,510	8,438	+36
Gas	232	197	175	1,992	1,611	+24
Dry	528	355	334	3,376	3,078	+10
Per cent dry	27.9	20.2	23.4	20.0	23.4	− 3.4
Wildcat wells	331	345	303	3,511	3,049	+15
Oil	40	47	38	433	397	+ 9
Gas	6	13	7	108	61	+77
Dry	285	285	258	2,970	2,591	+15
Per cent dry	86.1	82.6	85.1	84.6	85.0	− 0.4
Crude production	142,650	147,160	133,646	1,532,939	1,368,024	+12
Daily average	4,755	4,747	4,455	4,576	4,096	
Crude stocks	230,360	229,340	249,818	230,360	249,818	− 8
Days supply	48	48	56	48	56	
Crude demand†	145,312	149,136	134,540	1,586,689	1,391,474	+14
Daily average	4,844	4,811	4,485	4,736	4,166	
Natural gasoline production	8,810	8,990	7,887	92,935	82,581	+13
Daily average	294	290	263	277	247	
Motor fuel production	64,771	65,640	55,692	677,739	553,336	+22
Daily average	2,159	2,117	1,856	2,023	1,657	
Gasoline yield, per cent	40.7	39.6	38.7	39.3	37.1	+ 2.2
Motor fuel stocks	70,288	69,450	64,499	70,288	64,499	+ 9
Days supply	33	33	35	33	35	
Motor fuel demand	63,933	65,690	54,758	675,202	564,241	+20
Daily average	2,131	2,119	1,825	2,016	1,689	
Fuel oil stocks	102,240	105,750	97,852	102,240	97,852	+ 4
Days supply	50	56	48	50	48	
Fuel oil demand	60,910	58,275	60,806	651,680	604,449	+ 8
Daily average	2,030	1,880	2,027	1,945	1,810	
Refinery still runs	140,250	142,165	126,473	1,519,209	1,297,682	+17
Daily average	4,675	4,586	4,216	4,535	3,885	
All refined stocks	255,340	260,500	231,426	255,340	231,426	+10
Days supply	50	53	49	50	49	

*Unless otherwise stated all figures represent thousands of barrels. ¶Includes benzol. †Domestic and Foreign. (r)—Revised estimate. (p)—Preliminary. §No change since prices frozen. Prices do not include subsidies.

Economic Position of Petroleum Industry

First eleven months, 1944.

	Normal	Actual	Per cent of normal
Drilling (wells completed)	21,966	20,389	93
Production (daily average)	4,675	4,576	98
Refining (daily still runs)	4,635	4,535	98
Stocks (crude and refined)	585,700	485,700	83
Price of crude (per bbl.)	$1.96	$1.22	62

Crude Prices by States for November, 1944§

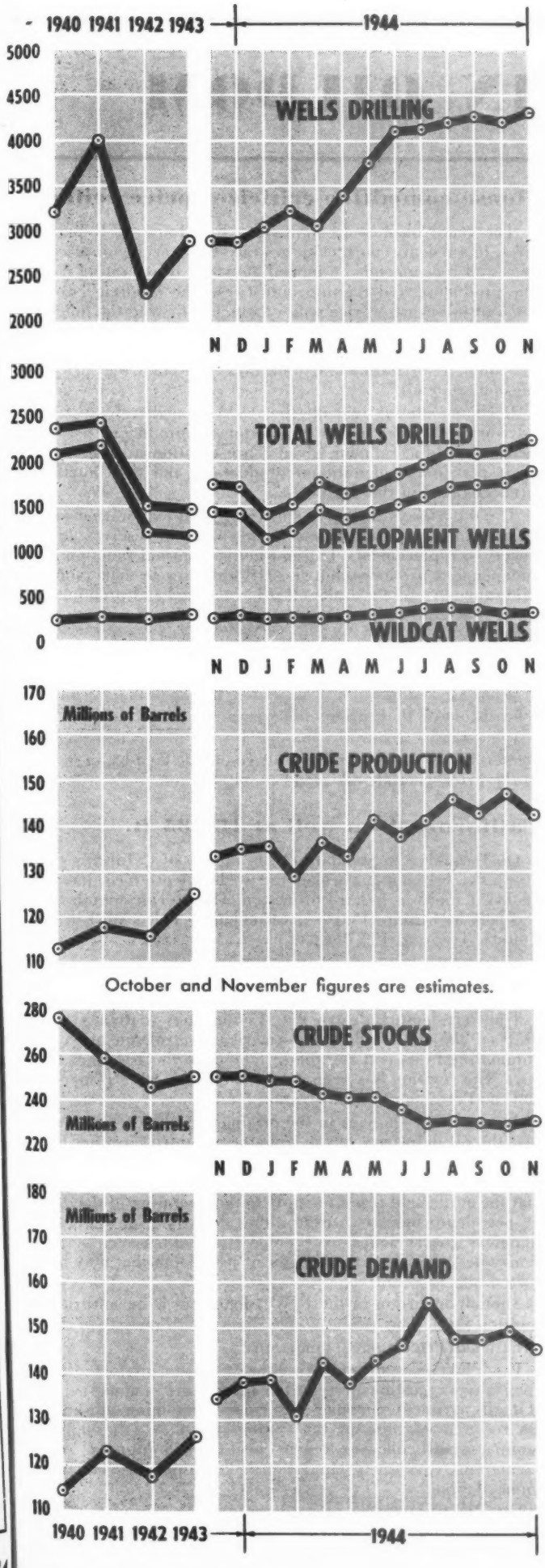
U. S. average	$1.22	Louisiana	$1.20
Texas	1.23	Arkansas	1.25
California	1.07	New Mexico	1.04
Oklahoma	1.17	Mississippi	1.10
Kansas	1.17	Illinois	1.37
		Other States	1.89

Basic crude prices

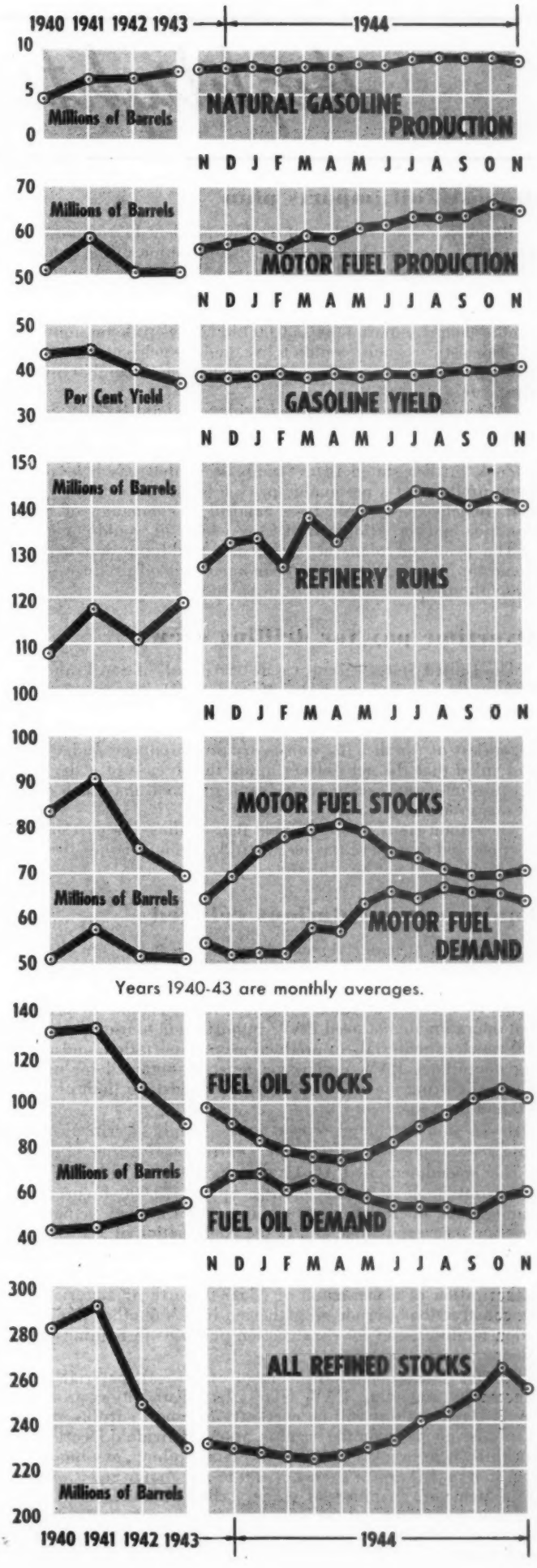
Oklahoma-Kansas (36 gr.)	$1.17
Texas Gulf Coast (36 gr.)	1.40
East Texas	1.25
West Texas (36 gr.)	1.04
Calif., Signal Hill (26 gr.)	1.11
Pennsylvania Bradford	3.00

Drilling and Production Statistics by States

	Nov. 1944(p)	October 1944(p)	Nov. 1943	This year to date	Last year to date	Per cent change
Total wells drilled	2,225	2,102	1,732	20,389	16,176	+26
Texas	520	525	440	5,166	3,949	+31
California	160	188	157	1,800	1,281	+41
Oklahoma	203	163	116	1,617	1,086	+49
Kansas	176	175	163	1,698	1,542	+10
Louisiana	86	65	72	719	633	+14
Arkansas	14	17	32	249	247	+ 1
New Mexico	26	47	21	363	214	+70
Mississippi	20	9	17	127	97	+31
Illinois	217	194	131	1,715	1,611	+ 6
Other States	803	719	583	6,935	5,516	+26
Wildcats drilled	331	345	303	3,511	3,049	+15
Texas	115	109	98	1,244	1,007	+24
California	16	17	14	183	180	+ 2
Oklahoma	38	30	23	342	278	+23
Kansas	41	58	43	482	419	+15
Louisiana	14	13	14	122	115	+ 6
Arkansas	6	5	5	58	62	− 6
New Mexico	3	4	4	57	46	+24
Mississippi	7	2	5	73	41	+78
Illinois	40	43	37	345	400	−14
Other States	51	64	60	605	501	+21
Daily crude production	4,755	4,747	4,455	4,576	4,096	+12
Texas	2,143	2,154	1,947	2,037	1,601	+27
California	892	888	794	851	777	+10
Oklahoma	367	342	337	339	338	0
Kansas	268	275	277	271	293	− 8
Louisiana	358	353	347	353	338	+ 4
Arkansas	80	83	80	81	75	+ 8
New Mexico	104	103	112	108	105	+ 3
Mississippi	51	48	47	44	52	−15
Illinois	207	200	223	211	226	− 7
Other States	285	301	291	281	291	− 3



October and November figures are estimates.



Years 1940-43 are monthly averages.

Highlights IN OILDOM

Opposes oil imports plan

Ralph T. Zook, president of the Independent Petroleum Association of America, has declared his opposition to the program of oil imports proposed by the National Planning Association. The planning group, in its report entitled "America's New Opportunities in World Trade," suggested that by 1950 the United States should import 1,000,000,000 bbl. of petroleum annually.

"Domestic refiners couldn't live under such conditions, because the American markets for fuel would not gain that much," Zook said.

"Monopolies and cartels in petroleum would be fully established under such a program," he said. "One billion barrels of oil represents 60 per cent of our wartime production in 1944."

Zook further stated that, "competition that has held petroleum products at a reasonable price level in this country would end. Beneficiaries would be a handful of companies of South America and the Middle East from where oil would come."

The proposed plan, he asserted, "would put hundreds of domestic refiners, thousands of independent oil producers, and many thousands of dealers out of business."

Overtime pay for drilling crews

The United States Circuit Court of Appeals at San Francisco, California, has reversed Judge Peirson M. Hall of Los Angeles and held that under the fair labor standards act employees of oil well drillers, if worked overtime, must be paid overtime wages regardless of whether the well is dry or a producer. Judge Hall had ruled that the act did not apply in the case of a dry hole because interstate commerce was not involved, inasmuch as no oil was produced.

The circuit court, however, held that drilling is a part of production, and that there was no way of knowing whether the well would or would not be a producer.

Equipment regulations relaxed

Relaxation of material controls in certain petroleum production, transportation, and refining operations has been announced by Deputy Petroleum Administrator Ralph K. Davies. Amendments to Petroleum Administrative Orders 11 and 15 provide that operators do not need PAW authorization to use up to $25,000 worth of materials in production, transportation, and refining operations. PAW permission must be obtained for use of material costing more than $25,000. Previously, a limit of $10,000 had been in effect.

Davies said that improvement in the supply of critical materials made it possible to relax the controls at this time.

The amendment to PAO-11 permits the use without PAW authorization of materials costing up to $25,000 in pressure maintenance operations, gas cycling, gas treating, in natural gasoline recovery plants, and in the construction of natural gas gathering lines.

The amendment to PAO-15 permits the use without PAW authorization of a maximum of $25,000 worth of material for the construction of crude oil gathering lines and other transportation facilities, and for construction purposes in refining operations.

Further relaxation of the control of critical materials was effected by amending PAW materials redistribution program No. 2. Davies said it will be necessary to report surplus stocks of tubular goods when the surplus, at any individual location or stockpile, is in excess of 1000 ft. of casing, tubing, or pipe from 2 in. to 8 in. I.D., or in excess of 500 ft. of tubular goods over 8 in. in diameter. Surpluses of refinery, distribution, and marketing materials need not be reported. Prior to the amendment petroleum operators were required to report surplus materials of all kinds.

House committee criticizes price ceiling

The small business committee of the House of Representatives, in a recent report, criticizes the OPA's crude oil price ceilings and recommends an immediate study of operating costs in the producing and refining industries. The report accuses the OPA of following a price policy "which is driving the independent producer of petroleum out of business." The report also criticizes OPA for "not giving sufficient attention to the need for inclusion of amortization of exploration costs in current price ceilings on crude oil."

Recommendation is made that OPA immediately appoint an advisory committee to represent crude oil producers, with independent producers being given representation in proportion to their percentage of national production, and the "number of firms engaged in that business."

The report says further: "Only increased exploration will enable us to regain the balance between use of reserves and discovery of replacements. Exploration is a normal function of the independent producer, but the OPA refuses to make sufficient allowance in present crude oil price ceilings and premium payment procedures to encourage further exploration by the independents."

OPA should grant such overall increases in the price of crude oil on a nationwide basis as will permit all producers whose operations are conducted in a normal and efficient manner to make a fair profit on their production operations.

If necessary a subsidy should be paid to the marginal cost refiner "whose prices might be adversely affected by an increase in the price of crude oil," the committee said.

California deep well at 16,085 ft.

On December 8, Standard Oil Company of California's KCL 20-13, the well that has broken the world's depth record, reached 16,085 ft. and was in hard formation. The previous depth record was held by Phillips Petroleum Company's Price No. 1 in Pecos County, Texas, at 15,279 ft.

PIWC rewrites oil agreement

The Petroleum Industry War Council has written a revised draft of the proposed Anglo-American petroleum agreement, eliminating in its text certain of the industry's objections to the pact. The revision has been submitted to the State Department and the Petroleum Administration for War.

Among other changes in the original text, the revision states that the oil industries of the signatory countries are not bound to comply with any reports and suggestions of the International Petroleum Commission. The new PIWC document also provides that the agreement is not to apply to the operation of the domestic petroleum industry within either country. Nor shall either signatory government be prevented from taking such action as it may desire to limit the amount of petroleum that may be imported into its country.

Another inclusion in the PIWC document is an antitrust exemption for actions taken in compliance with reports of the International Petroleum Commission.

The PIWC would not have either government forced to act upon any suggestion or report made by the commission. The State Department document provides "that upon approval of the recommendations of the commission they (the signatory countries) will endeavor to give effect to such approved recommendations." No such stipulation is contained in PIWC's recommendations.

The PIWC document was prepared by the national oil committee of which A. Jacobsen is chairman. It was adopted unanimously by the council.

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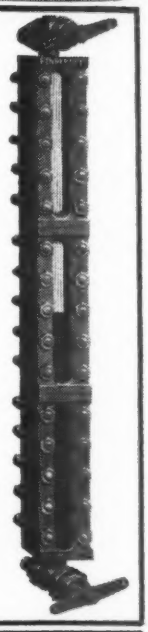

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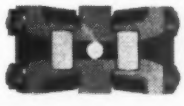

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MAJOR *Oil Field* ACTIVITIES

▸ **TEXAS.** Continental Oil Company announces discovery of a new oil pool on a 3700-acre unitized block in Cabeza Creek area, Goliad County. The discovery is the J. E. Pettus No. 3, producing from the first Wilcox sand 258 bbl. of 39-gravity oil in 24 hr. The producing zone is from 7588-7607 ft.

A new pool for Hardin County was opened recently with completion of Sun No. 1 Merchant, Stephen Jackson survey. The well had a potential of 132 bbl. of 29-3-gravity oil daily at 6335-65 ft. This is the deepest well ever drilled in the vicinity.

James W. Stewart Construction opened a new Caddo pool with No. 3 E. B. Madden wildcat 3 miles southwest of Wichita Falls, Wichita County, recently. The well, in block 8, William Mayer survey 193, is several miles from any other production. In 6 hr. the well flowed 360 bbl. of 43-gravity oil.

A new gas pool for South Texas has been opened by Ray Reynolds No. 1 Sallye Ragsdale, James McConnaughey survey. The test was drilled to 5976 ft., 5½-in. casing set at 4543 ft.

Skelly Oil Company has extended its reserves to the upper Texas Gulf Coast with the opening of a gas-condensate pool in the Van Vleck area of Matagorda County. The discovery is the No. 1 Granbury, which flowed 42 bbl. of 51-gravity water white condensate with 21,137,000 cu. ft. of gas. Production was through casing perforations from 8739-47 ft. with total depth at 10,010 ft.

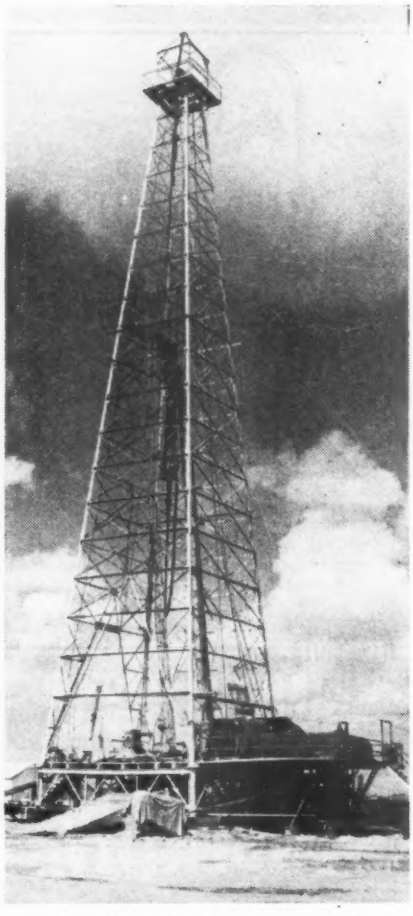
The No. 1-C Jefferson Land is a new pool opener in the Lovell Lake area of Jefferson County. A Humble Oil and Refining Company producer, the new well had a daily potential of 345.96 bbl. of 28-gravity oil from 7116-20 ft.

Humble Oil and Refining Company made a major strike when it opened a new field in Hopkins County recently at No. 1 Nichols, Friddle survey, 15 miles southeast of Sulphur Springs. On a 6.5-hr. flow test, the well gauged 37.85 bbl. of 48-gravity crude oil from casing perforations opposite the Bacon lime at 7888-96 ft. On another test the discovery flowed 140.65 bbl. of oil in 6 hr.

▸ **MISSISSIPPI.** Gulf Refining Company's No. 1 Cooper, section No. 7-1n-16w, Lamar County, has opened a new pool for Mississippi and extended the producing zone of the state farther south. The well has been completed to flow 25 bbl. of oil an hour through 144 casing perforations from 8690-8714 ft. in the upper section of the massive Tuscaloosa sand. Drilled to a total depth of 9080 ft., the well was plugged back and is producing oil of 16.4-gravity.

▸ **OKLAHOMA.** A belated pool opener for the Stratford area of northeastern Garvin County, sought for several years by different operators, was assured recently with the opening of No. 1 Rakestraw by Skelly Oil Company and Tide Water Associated Oil Company. The wildcat, good for 100 bbl. of oil a day from the 2500-ft. Pennsylvania horizon, is in SE SW SE of 4-4n-3e. It is on a sizable block held by both oil firms, was drilled originally to 3401 ft., tested dry, and was plugged back.

A. W. Swift, L. Deffenbaugh, and R. T. Lamb opened a new producing zone for the Sand Springs area with No. 3 Anthis in NE SW SW of 13-19n-10e. The well is producing at 200 bbl. of oil a day from the Mississippi or Big Lime sand at 1177 ft.



Standard Oil Company of Texas No. 4 Garcia, a semi-wildcat with four high pressure gas sands. ***(See article on Page 119.)***

▸ **ILLINOIS.** Deep Rock Oil Corporation opened a new pool in Franklin County with its No. 1 Kirk CNE SE SE 15-7n-4e. Producing from the McCloskey lime at a total of 3152 ft., the well made 192 bbl. of oil while cleaning out after a shot with 60 qt. of nitro-glycerine.

With an estimated production of from 500 to 1000 bbl. of oil daily, the No. 1 Clyde Russell is a new pool opener for Hamilton County. The well, situated in the SW SE SW of 17-7s-52, 4 miles east of Thompsonville, is owned by Sinclair Wyoming Oil Company. The producing zone is from 3129-39 ft. with total depth at 3149 ft. Experts have called it "the best Aux Vases well found in the Illinois Basin in several months."

Dr. J. J. Deaner has opened a new lower McCloskey lime well for White County, southern Illinois, with No. 1 Lawrence A. Brown, in SW NE SE of 16-6s-10e. The well first showed oil in the Aux Vases. The McCloskey showing came at a depth of 3017-26 ft. Production of the well was not announced.

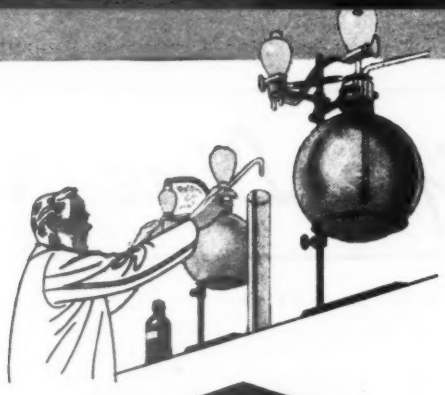
▸ **KANSAS.** A new production area was assured Graham County by Skelly Oil Company with its No. 1 Davis in the NW NW NW of 15-7-22w, 7 miles northeast of Hill City. The well has an initial rating of 518 bbl. of oil daily from the Lansing-Kansas City lime at a total depth of 3539 ft.

Clifton Gall and associates No. I Livengood, a rank wildcat in NE NW SW of 3-1-15e, five miles south of the Falls City pool of Richardson County, is a pool opener in northern Brown County, northeast Kansas. It tested successfully for 100 bbl. of oil daily. Production is from the Hunton lime at 2578-90 ft.

Phillips Petroleum Company has announced discovery of a new Arbuckle lime pool in Stafford County. The discovery, the company said, is the result of the completion of its No. 1 Vivian well, a wildcat expected to produce approximately 350 bbl. of oil a day. The discovery is 5 miles northwest of the Zenith pool, and is in the center of the company's 1280-acre block.

▸ **MONTANA.** Marking what is believed to be the most important oil field yet found in Montana, General Petroleum Company and Resolute Oil Corporation's No. 1 well, 25-9s-22e, flowed at the rate of 1000 bbl. a day on early tests. The well is located 6 miles northwest of the Elk Basin oil and gas field in Clark's Fork structure, Carbon County. It is a few miles north of the Wyoming-Montana border. Production of the gusher is from the Frontier sand.

▸ **LOUISIANA.** Gulf Refining Company and Ohio Oil Company have opened the Cotton Valley section of the Jurrasic to oil production with discovery well, No. 1 Taylor. Situated in Claiborne Parish, North Louisiana, in section 15-23-8, the well produced 337 bbl. of 43.8-gravity light oil with gas-oil ratio of 1061 cu. ft. to 1 bbl. from 8835-75 ft. The discovery opens new reserves in the old Haynesville pool, which, since its discovery 23 years ago, has produced almost 100,000,000 bbl. of oil. Several gas-condensate producing zones were found below the oil pays and will offer attractive goals for other operators in the pool to drill deeper as original production declines.



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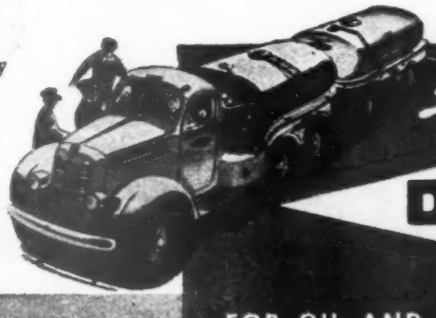

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MAJOR *Pipe Line* ACTIVITIES

TO INVESTIGATE LINE. The Texas Railroad Commission has refused to waive hearing on a proposed pipe line to carry South Texas natural gas to Monterrey, Mexico, according to Chairman Beauford H. Jester. Application for the line is pending before the Federal Power Commission, and it was requested that state investigation be waived.

Reynosa Pipeline Company proposes to build a 14-in. line from La Blanca, South Weslaco, and North Weslaco gas fields in Hidalgo County, Texas, and to purchase 40,000,000 cu. ft. of gas daily from the LaGloria Corporation, later increasing the amount to 60,000,000 cu. ft. if needed, Jester said. The pipe line proposes to deliver the fuel to Gas Industrial de Mexico, S. A., for use in Monterrey industries. Two other lines now carry Texas Gas to Mexico, Jester said.

RESERVE LINE. The Texas-Empire Pipe Line Company is laying an auxiliary line as a safety carrier, supplementing a similar line already in operation, across the Arkansas River near Sand Springs, Oklahoma. Anderson Brothers pipe line contractors and engineers, Tulsa, Oklahoma, are laying the 12¾-in. string of heavy river crossing pipe. The line will be double coated. It will have a minimum of 5 ft. of coverage under the lowest part of the river and will extend 400 ft. in each bank on a level with the river pipe.

MEXICO PLANS LINES. Construction of four new pipe lines, a fleet of tankers, and a new refinery by Pemex, the Mexican government oil company, has been announced by *Petroleo Del Mundo*, Spanish language oil magazine. Largest of the four lines will run from the oil fields near Tampico on the Gulf Coast to the Pacific seaport of Mazatlan and will cost $3,093,000 to construct. The government is attempting to develop this region as the chief West Coast petroleum center, the announcement said.

Another pipe line will extend from the Ebano oil fields on the East Coast to San Luis Potosi, important mining center. The third will connect the San Benito fields south of Vera Cruz with Tapachula on the Guatemalan border. Cost of these two pipe lines will be approximately $2,062,000. The fourth line will extend from Tamasopo near Tampico, to Cardenas, an important railroad junction in the state of San Luis Potosi. This line is being built by Mexico's national railways in cooperation with Pemex at an estimated cost of $618,000. When completed, this line will release much of Mexico's rolling stock, now employed in carrying petroleum products, for other needs. The plan is to move the oil by tankcars from the oil fields to Tamasopo and then pump it through the pipe lines to Cardenas.

Pemex has contracted for the construction of 22 tankers of steel and concrete design, for coastwise traffic and for shipment of oil products to Central and South America. First of these tankers is expected to be ready by this year.

NEW OUTLET PLANNED. Gulf Refining Company has proposed further outlet for the fast-growing 10,000-ft. sweet oil production in the Keystone Pool, Winkler County, West Texas Permian Basin, by means of a 63-mile, 8-in. pipe line. The artery, to be built from the pool by way of the Goldsmith pool of Ector County, to Gulf's West Texas tank farm and terminal at Midland, Texas, would also traverse the new three-pay area indicated by a wildcat being drilled by Cities Service Oil Company and Shell Oil Company, Inc., on land owned by the Texas Pacific Land Trust in western Ector County. Gulf pays $1.25 a bbl. for the Keystone production and handles it on a common carrier basis for Magnolia Petroleum Company in order to segregate the sweet oil from Magnolia's sour crude purchases in the district. The proposed new line would accept the sweet crude from the Goldsmith pool gathered by Standish Pipe Line Company, a subsidiary of Phillips Petroleum Company.

ODT REENACTS TANKCAR RULE. The Office of Defense Transportation has reinstated the provision in its General Order 7, recently revised, requiring that shippers and carriers obtain permits for movement for petroleum and its products in tankcars for 200 miles or less. The critical shortage of tankcars that has recently developed, especially on the West Coast, is responsible for the reinstatement, officials said. Shortage of tank truck tires has apparently been a contributing factor in holding up the restoration of the 200-mile limit previously.

Construction scene on Tennessee Gas and Transmission Company line taken near Spring Creek, Texas.

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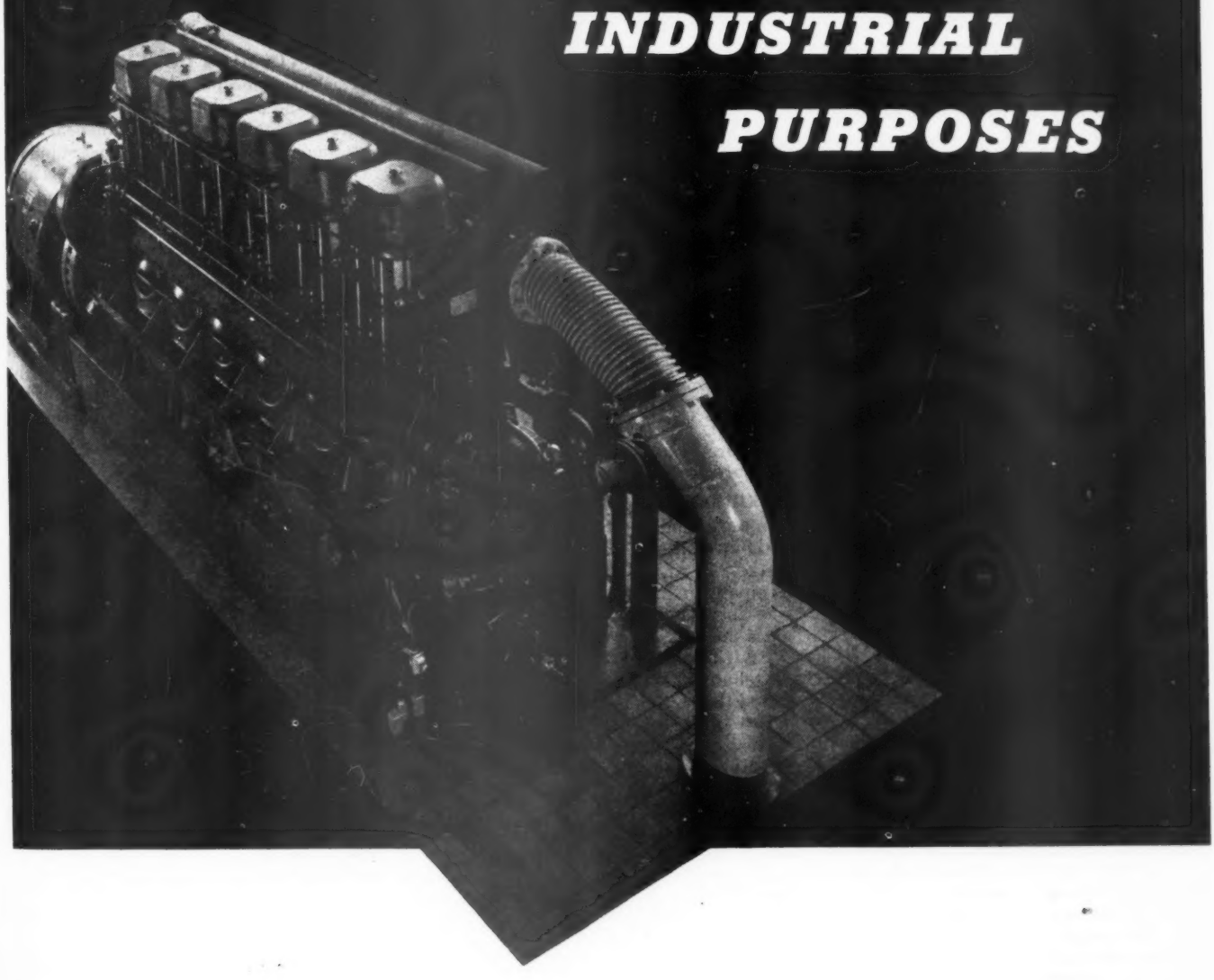

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DIESEL ENGINES

MAJOR *Refining* ACTIVITIES

BAY BUYS CHALMETTE. The Bay Petroleum Corporation of Denver, Colorado, has acquired control of the Chalmette Petroleum Corporation, New Orleans, Louisiana, for an estimated $1,000,000. Chalmette operates a 9000-bbl. modern refinery near New Orleans with a barge loading terminal on the Mississippi River, and tankcar and truck loading facilities. It occupies a site of 55 acres with a 750,000-bbl. capacity tank farm.

The Bay company will continue to operate the plant under the name of Chalmette Petroleum Corporation. In addition to Chalmette, the company operates refineries at Denver, Colorado, and McPherson, Kansas. Bay Petroleum is headed by C. U. Bay of New York. It has oil production operations in Illinois, Texas, Kansas, New Mexico and expects to open production offices in northern Louisiana or Mississippi. New officers of the Chalmette company will be: Charles Ulrich Bay, chairman of the board; Roland V. Rodman, president; C. O. Garbrecht, vice president; Dent N. Hand, secretary and treasurer; Leo L. Leabo, director of sales, and L. E. Vivien, general manager.

GOODRICH BREAKS RECORD. "Rubber Rancho Grande," the giant government synthetic rubber plant at Port Neches, Texas, operated by the B. F. Goodrich Company, produced 100,000,000 lb. of man-made rubber up to November 5, company officials have announced. The large copolymer plant, which began producing synthetic rubber in August, 1943, operated a record total of 1,000,000 man-hours without a lost time accident for any member of its personnel, according to the company statement. The output of synthetic rubber in slightly more than 14 months is equivalent to the rubber yield of approximately 14,000,000 rubber trees during the same period of time, it was stated. Goodrich also operates government synthetic plants in Louisville, Kentucky, and Borger, Texas.

TO CONSTRUCT PLANT. Glenn H. McCarthy, Houston oil operator, has announced plans for construction of a $4,000,000 plant to manufacture automobile and aviation gasoline and for extraction of such by-products as butane and allied substances. Stone and Webster have been awarded contract for building the plant.

The plant will use the residue gas from the Stowell, Winnie, North Winnie, and other fields in the vicinity where McCarthy has been engaged for several years in developing his holdings. The gas will be stripped of gasoline, butane, pentane, and other products at the rate of an estimated 72,000 bbl. daily. After stripping, the gas will be pumped through a 25-mile 10¾-in. line to Beaumont and Port Arthur, Texas, and to the government rubber plant at Port Neches, Texas, for fuel.

PLANT FOR HEIDELBERG. Rogers Lacy Company of Longview, Texas, has scheduled an oil refinery to be built in the Heidelberg oil field area of Mississippi, according to a recent announcement by Governor Thomas L. Bailey after a conference with Lacy. The site and capacity of the plant have not been disclosed.

Heidelberg field, with a total of 50 wells, produced 251,043 bbl. of oil in October. The only other refinery in Mississippi, the Southland Refinery Company, Yazoo City, has a capacity of 3500 bbl. daily. State Oil and Gas Board Director H. Morse said that 15 additional wells are being drilled in the field, while 5 others are waiting for drilling rigs.

CORROSION CHECKED. Isomerization of normal butane can be carried out without equipment corrosion, according to the record of the Champlin Refining Company at Enid, Oklahoma. This plant was inspected early in October after more than six months' operation.

E. J. Slater, vice president in charge of refining of the Champlin company, stated that only minor evidence of damage to the equipment was found from corrosion and this was attributed to conditions existing and eliminated early in the plant's operation. This unit has an operation time factor of 90 per cent and has never required a shutdown because of corrosion. Feed to the unit is vigorously dried with regenerating bauxite dryers whose operation is supervised carefully to insure efficient water removal.

Initial operating assistance and technical assistance were supplied by Phillips Petroleum Company, which licensed this process. The Koch Engineering Company designed the plant and Champlin Refining Company built and is operating it. Results of this cooperative effort have been uniformly satisfactory. The unit has produced more than 200 gal. of isobutane per lb. of aluminum chloride used and more than 500 gal. per lb. of HCl used.

Caustic soda is also used at one stage of the process and consumption of this chemical has been negligible, about 6000 gal. isobutane being produced per lb. of caustic. This unit, despite its inadequate storage capacity, has been able to produce isobutane for outside sale as well as for Champlin's own operations.

SPECIALISTS CONFER. American oil and refinery specialists are conferring with Mexican authorities and aiding Mexican technicians in planning a new refinery. The plant will be situated at Atzcapotzalco, in the capital area. Work will be started on it early next year.

PLANTS MUST CONVERT. As rapidly as possible upon the cessation of hostilities the petroleum industry must convert its high-octane plants to peacetime methods, J. K. Roberts of the Standard Oil Company of Indiana said recently. He urged a quick conversion of facilities now manufacturing 100-octane gasoline, because he believes that high-octane fuels simply will not be made beyond the comparative small quantities required for postwar operations.

The principal reason for a hasty conversion, Roberts said, is that present wartime operations are punishing to the industry's program for efficient crude production and efficient utilization of crude oil.

SOUTH AMERICAN PLANT. The Colombian Tire Company, Bogota, South America, now nearing completion, will produce tires and tubes next year, according to The B. F. Goodrich Company officials, the company that will operate the plant. James M. Robbins has been named as technical representative to the South American plant. He formerly served the Goodrich company in California.

GULF PLANT ACTIVE. Gulf Oil Corporation has announced completion of its new oil lubricating refinery at Port Arthur, Texas. Consisting of a deasphalting plant, a phenol solvent extraction and a MEK dewaxing plant, the refinery will increase the company's output of lubricants by more than 1000 bbl. a day. The plant's entire output will be delivered to the United States Army Air Corps and the Navy Bureau of Aeronautics. Completed under WPB priorities, the entire project was financed with private funds, Gulf said.

The company also stated that the new plant can be used after the war for manufacture of aviation, automotive, and industrial oils. This is made possible by the design of facilities.

GETS ADDITIONAL CRUDE. Valley Refining Company of Artesia, New Mexico, has been assured additional crude oil for its plant with the laying of a 4-in. pipe line from the Caprock pool of northwestern Lea County, New Mexico, to the company's Dexter Pipe Line Station. Valley Refining operates a combination cracking and skimming plant.

Having a 1500-bbl. of oil daily capacity, Valley Refining has not been able to operate at full speed due to lack of outlet from the Caprock pool. The pool has six producers with a total daily production of 219 bbl. Both PAW and WPB have given approval for the new project.

THE Petroleum Engineer

DECEMBER, 1944

WEST COAST REFINING AND NATURAL GASOLINE CONSTRUCTION ASSUMES ADDED SIGNIFICANCE

By **JOHN H. KUNKEL,** *Refinery Editor*

EXCLUSIVE REFINERY-WISE, 1944 has been a banner year for California from the standpoint of new refinery units placed on stream, as well as from that of new construction begun during the year and major projects under way or planned for 1945.

At this moment of writing, high military authorities now foresee victory for the United Nations in the European theater bringing this phase of the global war to a successful conclusion. Indeed, there are some of the opinion that V-E day will be celebrated soon, whereas the more conservative foresee cessation of hostilities in Europe by the late spring of 1945. All, however, are agreed that, with V-E day, there can be no letup and the full might of this nation's arms and the tremendous power of her industries must be concentrated on the objective of securing a complete victory over the Japanese in the shortest possible time.

John H. Kunkel

From the foregoing, it therefore appears that, within a matter of months, military emphasis may shift from the European theater to the vast distances of the Pacific. Although all the country's refineries will be called upon for the full measure of their war product production, the fact that California's refineries are the nearest source of fuel supply to this theater serves to re-emphasize their importance in the war effort and the accomplishments in that area during the year now drawing to a close assume maximum significance. In preparation for this important effort, refinery after refinery in California reports the addition of new facilities this year that will double or more than double their output of petroleum products for war.

▶ **Standard of California.** In the San Francisco bay area, Standard of California is completing a huge $19,500,000 project for the production of 100-octane aviation gasoline components on a 40-acre tract at its Richmond refinery. According to schedule, the new plant is due to be completely on stream by the end of this month. It consists of 3 interrelated units, which include 2 TCC catalytic cracking plants, an HF alkylation plant, and an isomerization unit, together with supporting utilities of a size sufficient to supply the needs of a large city. The net effect of the project will be that of increasing Standard of California's already large output of 100-octane aviation gasoline at its Richmond refinery by 336,000 gal. per day. The new unit is owned by the Defense Plant Corporation.

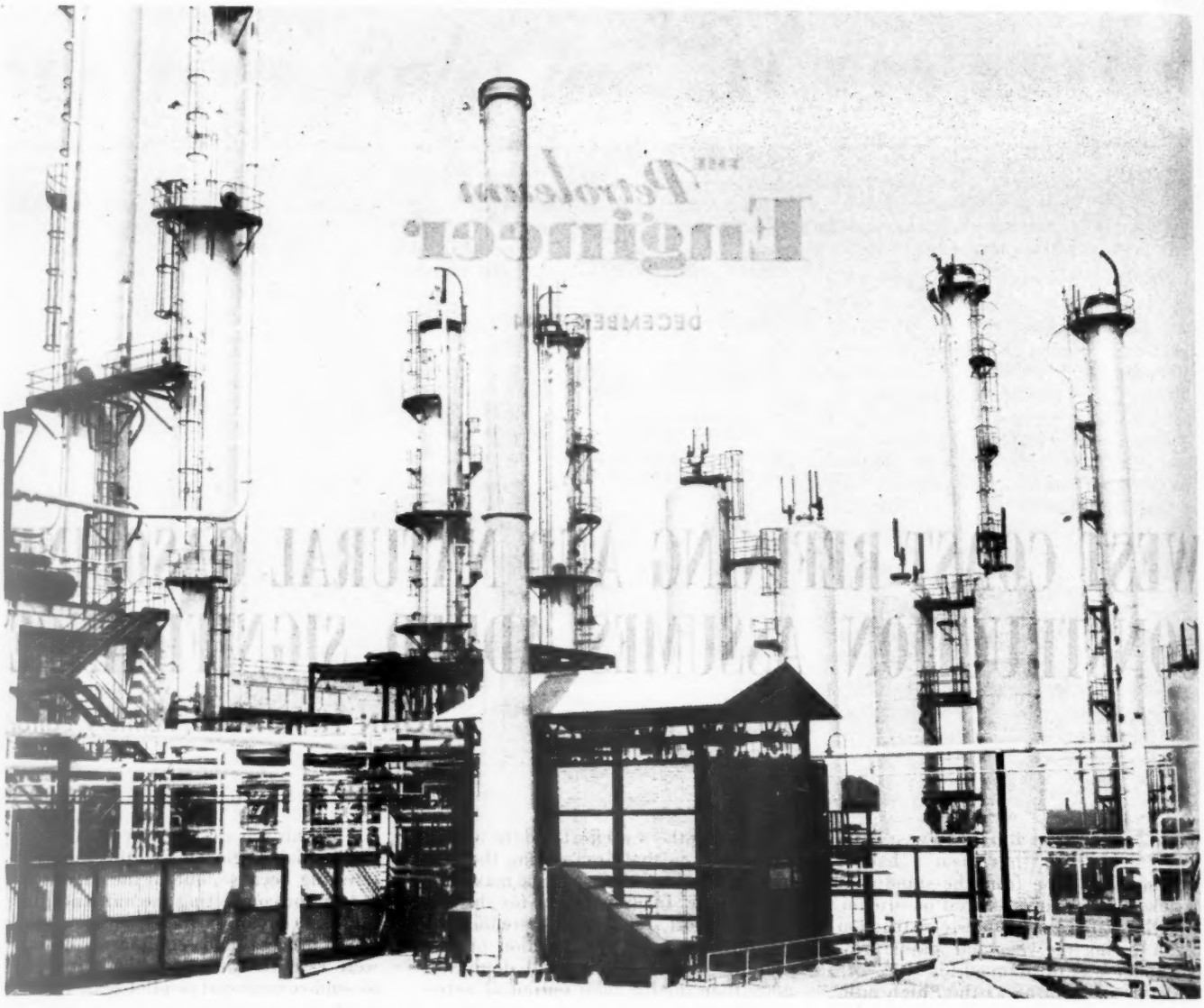
At its El Segundo refinery, Standard of California made a substantial contribution to the government's synthetic rubber program when it placed its new butadiene plant on stream in February. The production of this unit is rated at 15,000 tons of butadiene per year, which, when combined with 5,000 tons of styrene, is sufficient to produce 20,000 tons of buna-S rubber per annum.

The unit was designed by Standard of California's engineers and this fact is interesting because, due to the urgent necessity for completing the unit and placing it on stream in the shortest possible time, process and equipment designs were essentially made without recourse to semi-commercial or pilot-scale experiments.

Butadiene is produced by catalytic dehydrogenation of n-butane available at the refinery. The dehydrogenation process employed was originated by the Houdry Process Corporation and developed through the joint efforts of Houdry, the Catalytic Development Corporation, Sun Oil Company, and Standard of California. At the time of going on stream this was one of the first 2 plants in the United States then employing the Houdry butadiene process.

In this process, n-butane is dehydro-

California refineries have increased their facilities in anticipation of accelerated demand when military emphasis shifts to Pacific war theater.



General view of the Union Oil Company's new stabilizer plant.

genated when passed through a bed of catalyst at extremely high temperature, removing 4 atoms of hydrogen from each molecule. A portion of the n-butane is dehydrogenated to butadiene and some is converted to coke and light gases during a first pass through the catalyst. After removal of the light gases, which go to fuel, butadiene is recovered from the reaction products and the remaining B-B (butane-butene) mixture is routed back through the catalyst for further conversion.

Coke produced by decomposition reactions is deposited on the catalyst and is burned off at regular intervals by admitting air to the catalyst chambers. The quantity of air used in this step is in considerable excess over that required for burning the coke, thus providing a means of correcting any undesirable temperature change in the catalyst. Alternate dehydrogenation and coke burning periods are controlled by an electric cycle-timer.

While dehydrogenation is taking place, heat is absorbed from the catalyst, resulting in a decrease in its temperature. Conversely, when coke is burned from the catalyst, heat is liberated, resulting in a rise in catalyst temperature. The operations are so conducted that the heat absorbed during dehydrogenation is made to balance that liberated during coke-burning periods and thus equipment for adding or removing heat from the catalyst is largely eliminated.

The hot combustion gases leaving the catalyst chambers are passed through a bank of 10 waste-heat boilers and steam, at the rate of 55,000 lb. per hr., is thus generated for the operation of the plant's many pumps and for process heat.

The products from the dehydrogenation reactors are compressed to a liquid and butadiene is recovered therefrom by solvent extraction, the process used being that developed by Standard of New Jersey and released for use by operators in the synthetic rubber program. The compressor installation, the largest in the West, totals 7500 hp.

Because of the ease with which butadiene combines with itself to form heavy liquids or solids, it is necessary to add small amounts of a chemical that inhibits polymerization if butadiene is stored for more than a few days. The inhibitor is added to each tank of product as produced. The finished product is shipped to rubber companies in Los Angeles who combine it with styrene to make buna-S rubber. The butadiene plant is owned by Defense Plant Corporation, and is operated by Standard of California as agent under contract with the Rubber Reserve Corporation.

▸ **Oronite Chemical Company.** At a cost of $1,000,000 the Oronite Chemical Company, subsidiary of Standard of California, is erecting a new plant for the manufacture of phthalic anhydride, basic stock for alkyd resin paints and finishes. The plant, located at Richmond, was approved by the War Production Board in August and it will be the first of its kind west of St. Louis. It will not make finished products, but will act as a wholesaler to manufacturers.

Alkyd resin paints, which now go almost exclusively to war uses, are expected to play an important role in the postwar building construction field. They are more durable than prewar paints and are resistant to the deterioration caused by sun, heat, and moisture. Their preservative effect is even more pronounced when applied on metal than when applied on wood, and the U. S. Navy has found them highly resistant to salt spray and extreme changes of temperature. Because of these characteristics alkyd resin paints are being used on the San

Francisco-Oakland Bay bridge and the Golden Gate bridge.

Phthalic anhydride has a variety of other possibilities that are now being explored. Currently it is being used as the "starting" material for the manufacture of one of the new-type insect repellents that have been so important in maintaining the health of American fighting men in the South Pacific. Studies are being made to extend its uses to other chemical fields.

▸ **Tide Water Associated.** At Avon, California, the Tide Water Associated Oil Company this year completed a program that will increase that company's output of 100-octane aviation gasoline by 15 times that of its prewar figure. This is made possible by placing on stream its new single-pass fluid catalytic cracking unit, which will process 16,000 bbl. per stream day of charge or 14,000 bbl. per calendar day.

Augmenting the catalytic cracking unit is a feed preparation unit that was placed on stream in October and, with the completion of the catalytic cracking unit, Associated's new gas plant will be placed in operation. Other new facilities at Avon include a pentane isomerization unit handling a charge of 810 bbl. per calendar day and an extension of the existing sulphuric acid alkylation unit, charge of which was increased to 5000 bbl. per stream day.

▸ **Union Oil Company.** Beginning in March of this year in a veritable on-stream parade, Union Oil Company of California, at Wilmington, placed in operation a combination cracking unit, a Unisol plant, and a cracked gasoline rerun unit; in April an alkylation plant and an isomerization unit; and, in November, reached a climax when a new thermofor catalytic cracking unit was placed on stream to complete a $40,000,000 modernization project undertaken by that company for the maximum production of products required by the war effort. These include aviation, special government and domestic gasolines, diesel fuels, special navy fuels, domestic fuel oils, and stove oils.

Los Angeles basin crude is processed in the combination unit, producing therefrom aviation base stocks, toluene stock, stocks required for alkylation as well as motor gasoline, diesel, and heavy fuel oils. The combination unit includes gas polymerization facilities to realize maximum conversion of the gaseous fractions. In addition, it has a reforming coil for reforming heavy cracked gasolines produced in order to make maximum butylene for alkylation operations.

Heavy straight run naphthas produced by the combination unit are processed in a gas conversion unit to increase the availability of butylenes for alkylation. This unit also has complete polymerization facilities.

The new alkylation plant is confined to butylene alkylation (another alkylation unit completed in 1940 being used for pentene-amylene alkylation) and the most modern facilities are incorporated to obtain high knock ratings, low acid consumption, and maximum yields.

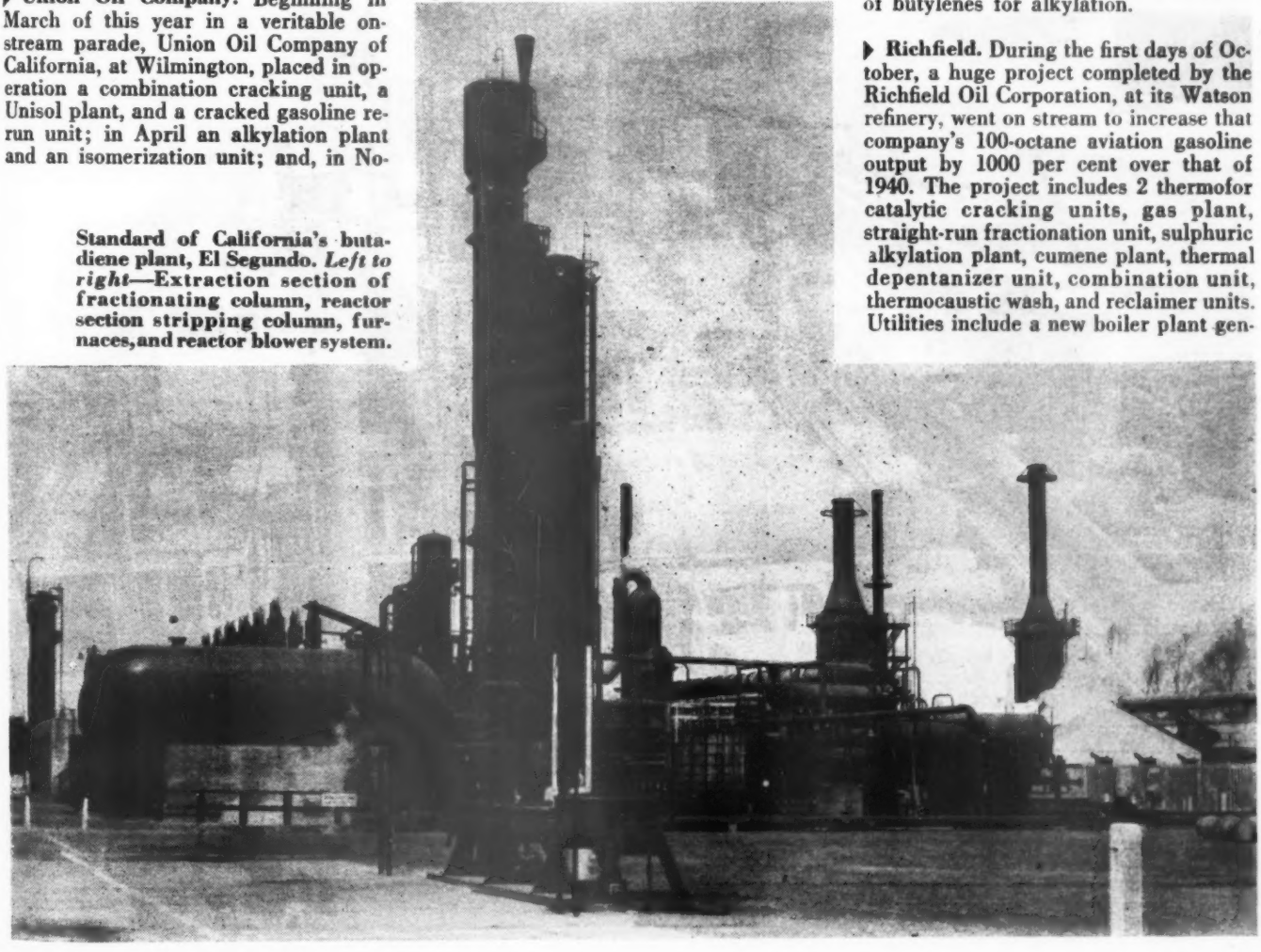
The isomerization unit is a vapor phase type producing isobutane for alkylation, while the thermofor catalytic cracking plant will augment supplies of aromatic-type base stock for aviation gasoline and, in addition, supply substantial amounts of butylenes for alkylation.

▸ **Richfield.** During the first days of October, a huge project completed by the Richfield Oil Corporation, at its Watson refinery, went on stream to increase that company's 100-octane aviation gasoline output by 1000 per cent over that of 1940. The project includes 2 thermofor catalytic cracking units, gas plant, straight-run fractionation unit, sulphuric alkylation plant, cumene plant, thermal depentanizer unit, combination unit, thermocaustic wash, and reclaimer units. Utilities include a new boiler plant gen-

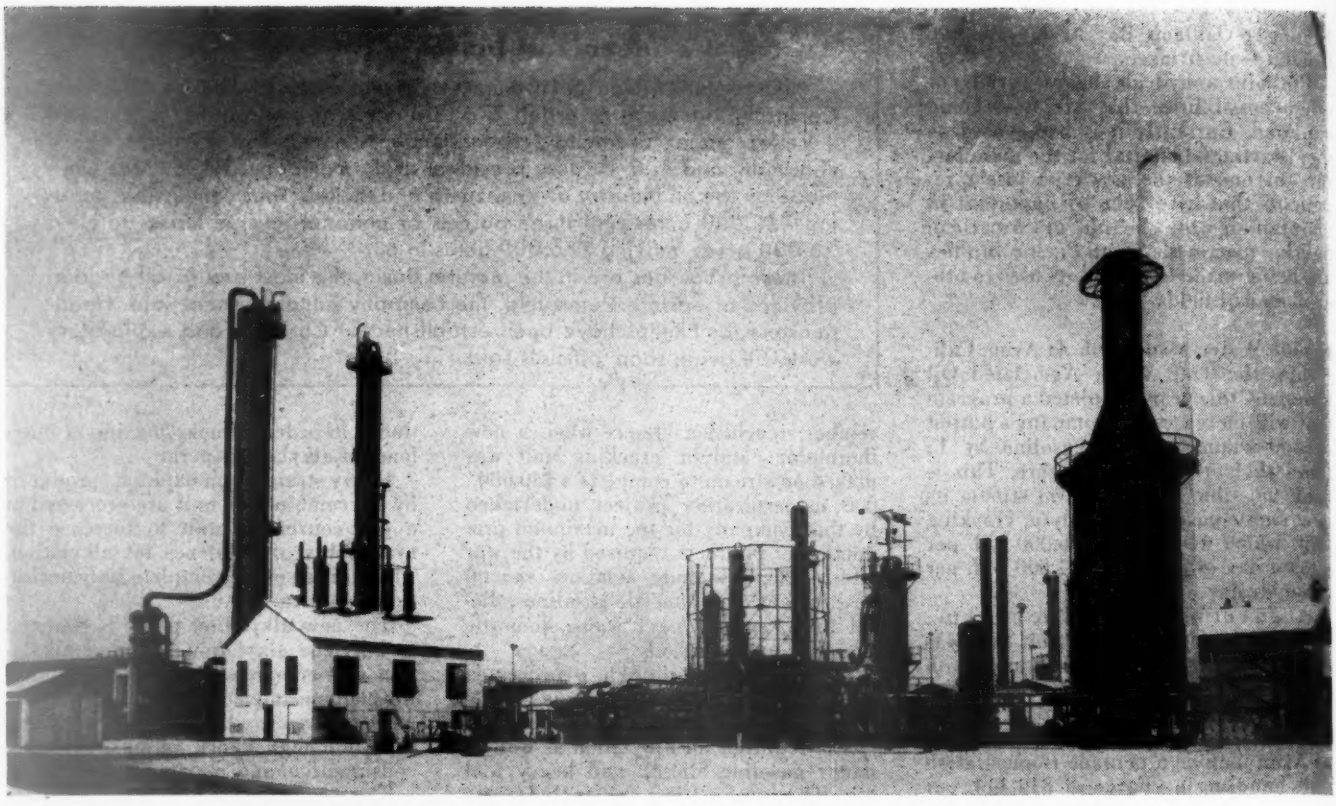
Awarded Venezuelan leases

Phillips Venezuelan Oil Company, a subsidiary of Phillips Petroleum Company, has been awarded 776,000 acres of exploratory concessions in Venezuela, according to a recent announcement by Frank Phillips, board chairman, and K. S. Adams, president of the company. The awards were made by the oil industry of Venezuela and include four concessions totaling 750,000 acres and three parcels of national reserve leases totaling 26,000 acres, making 776,000 acres in all.

These properties are in the Maturin Basin, the most prolific oil-bearing province of eastern Venezuela, the company announcement said. Headquarters for Phillips have been established at Caracas, and exploratory work will begin soon, officials said.

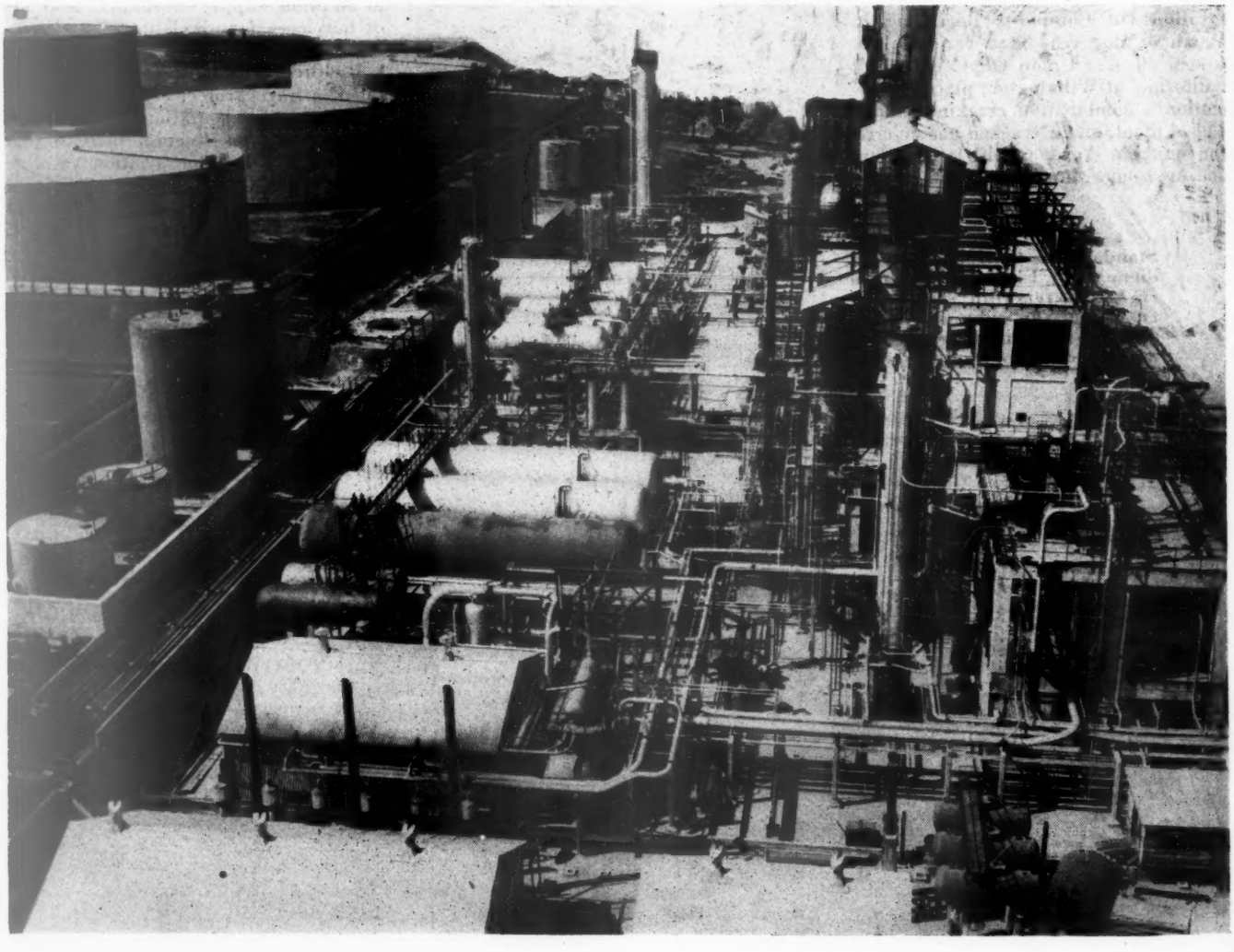


Standard of California's butadiene plant, El Segundo. ***Left to right*****—Extraction section of fractionating column, reactor section stripping column, furnaces, and reactor blower system.**



Above—**Shell's $3,500,000 catalytic hydrogenation plant at Wilmington-Dominguez refinery. This plant is producing 100-octane gasoline by a new process developed in the company's laboratories.**

Below—**General view of Union Oil Company of California's new alkylation and isomerization plants.**



erating steam at 600 lb. per sq. in. The boilers are gas-fired, but provision has been made for oil-firing in case of failure of the gas supply. Two new wells were drilled to supply 1500 bbl. per hr. of fresh water to augment the refinery's requirements and a new 40,000 gal. per min. induced-draft cooling tower was installed. A new 11,000—2300 volt main substation, and 2 secondary substations for reducing primary power from 2300 to 440 volts were included.

The catalytic cracking unit is a 2-pass system with the first unit cracking virgin gas oil, and the second unit re-treating the partially depentanized gasoline received from the first-pass operation. Natural clay catalyst is employed in the first pass, whereas a synthetic catalyst is used in the second pass. The new sulphuric alkylation unit processes butylenes and amylenes produced by catalytic cracking, the isobutane feed being obtained from straight run, from the n-butane isomerization unit as well as from the thermal and catalytic cracking units.

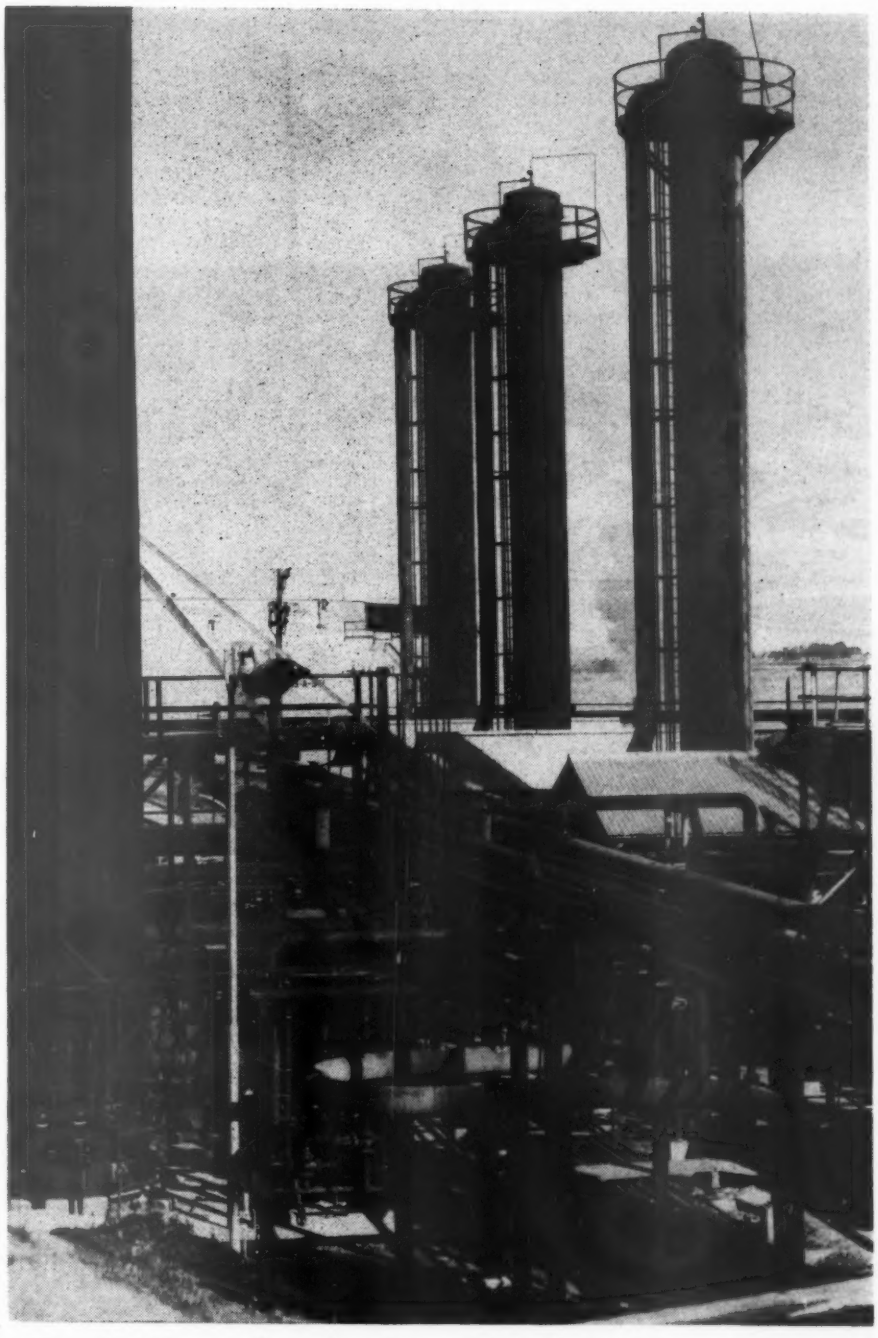
General Petroleum. By the end of June, the General Petroleum Corporation completed a $15,000,000 project for the initial production of 100-octane gasoline by that company at Torrance. This project involved the construction of a double thermofor catalytic cracking unit, each double unit being a 2-pass system, a gas plant to handle all refinery thermal and catalytic cracking gases, and an HF alkylation unit.

Each double TCC unit cracks on the first pass, and re-treats on the second pass. Each of the 4 units is designed to process 8000 bbl. per day of gas oil on the cracking side. The volume referred to represents that of the planned 2-pass operation for the production of catalytically cracked aviation base stock, whereas the normal rated capacity of each of the 4 units would be 20,000 bbl. per day for the production of motor gasoline. In the treating stages, for the separate units, bead catalyst is employed.

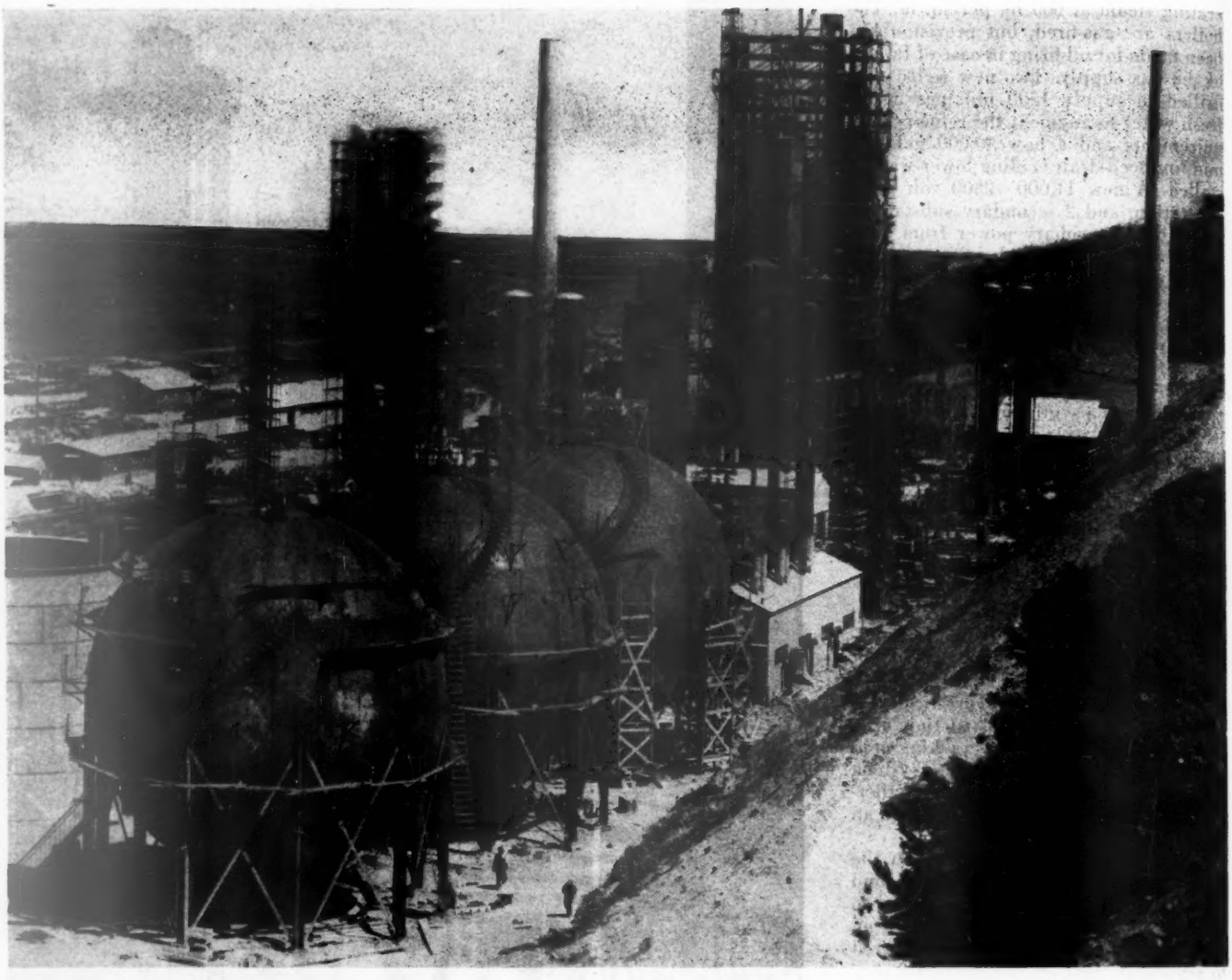
Because of the shortage of heavy gas oil on the Pacific Coast, the General Petroleum Corporation received approval from PAW and WPB for the construction of a delayed recycle coking unit at Torrance, which will represent an investment of approximately $5,000,000. The unit will produce cutter stock for navy fuel, additional charging stock for catalytic cracking operations, and added butylenes for the alkylation plant.

Shell Oil Company, Inc. In 1944 Shell in California has topped off its program for wartime production of aviation gasoline with the completion of the hydrogenation plant at its Wilmington refinery. This prototype plant started operation March 18, 1944, and required 11 months to construct. Costing approximately $5,000,000, it consists of a high pressure catalytic hydrogenation unit and a two-column fractionation unit for feed stock distillation. Employing by-product hydrogen and a rugged catalyst developed by Shell, the plant can process fractions from cracking and from butadiene by-products to produce an aviation base stock of highest quality from these materials previously unusable for aviation gasoline manufacture. An increment of several thousand barrels of 100-octane aviation gasoline per day is realized from this installation and augments in a gratifying manner the already high output of aviation gasoline per barrel of crude charged at this refinery.

A major factor in achieving this high ratio of aviation gasoline production is the fluid catalytic cracking plant. The first to be completed of all those authorized after Pearl Harbor, this unit began operation in November, 1943. Costing $15,000,000, the unit required 19 months for design and construction. Its design has become standard for this type of equipment, and is undoubtedly so familiar to the industry that detailed discussion is not required here. A new tool in the refining industry, the catalytic cracker, has been very effective and has met all expectations. As a means of producing maximum aviation gasoline, the fluid bed system has the advantage of high allowable operating temperatures with a resulting high proportion of base materials for aviation gasoline synthesis. At Wilmington refinery this construction included sulphuric acid alkylation facilities and Shell type liquid phase butane isomerization units, the latter bringing total production of isobutane to a volume adequate for the alkylation of all available olefins. This has resulted in balanced operation in aviation alkylate manufacture. The feed fractionation facilities of this catalytic cracking plant are capable of preparing a feed stock



View showing a small portion of the Tide Water Associated Oil Company's Avon refinery alkylation unit. At the extreme left is No. 2 deisobutanizer. The three columns in the center are reactors.



New TCC unit and alkylation plant of Standard of California at Richmond.

consisting of flash distillate and/or virgin naphtha while allowing the recovery of the virgin diesel fuel in the intermediate range. This is a distinct advantage over the usual operation, where this diesel fraction is used as feed stock for catalytic cracking, particularly in view of the extreme demand for diesel engine fuel for war use.

Despite the necessity for meeting difficult operating conditions, Shell's use of materials, particularly in the field of conservation of alloys and steel, has received wide acclaim. In some cases the bold substitution of carbon steel for alloy has enabled plants to come on stream in a fraction of the usual time normal to wartime construction and, although equipment life obviously might be reduced by this process hence cost increased per unit of product, it has enabled rapid increases in overall production of 100-octane gasoline that otherwise might not have been possible.

The California toluene installation utilizes the Shell process for the recovery of toluene from petroleum utilizing chemical conversion by isomerization and dehydrogenation of suitable starting materials concentrated in the feed by careful prefractionation. Toluene of 99.9 per cent purity is separated from the crude products from chemical synthesis by the process of extractive distillation. Including facilities to manufacture catalyst for the dehydrogenation step, the total capital cost was approximately $5,000,000 and was completed on schedule 12 months after approval of the project. Recovery of natural toluene began in December, 1942, followed by manufacture of synthetic toluene in January, 1943. The ability of this plant to concentrate selectively methylcylohexane and dimethylcyclopentane by fractionation makes possible the recovery through suit-

New method converts gas into gasoline

A new process whereby gasoline may be made from natural gas has been acclaimed as a great success, according to Texas Railroad Commission member, Ernest O. Thompson. The new process of converting methane into gasoline was worked out and engineered by C. F. Keith. In explaining the results obtained by the new process, Thompson said:

"Methane is what is left after the liquid hydrocarbons like butane and propane have been extracted from the natural gas. Some gas wells in Texas are closed in because of no market. Gas has been selling for as little as one, two, three, and four cents a thousand. With this new process this same gas is worth perhaps ten cents a thousand at the well. A plant that will use 64,000,000 cu. ft. of methane per day will produce about 6,000 bbl. of 83-octane gasoline daily—that means about one barrel of gasoline from each 10,500 ft. of methane. These plants can be constructed in the Texas gas fields, thus providing outlets for gas in fields that do not have pipe line connections."

Thompson pointed out that by such a method conservation will be made vastly more simple. "It is difficult to get people to conserve something that has no sale value," he said. "Now as the gas becomes valuable to its owners it will be simple to get them to conserve it as a matter of self-interest."

able isomerization and dehydrogenation steps of virtually all materials present either as toluene, as is now the case, or alternatively as a pure material for other chemical synthesis.

The Texas Company. An additional crude still unit, additional fractionating capacity, installation of a new fluid catalytic cracking unit, a new HF alkylation plant, new tankage facilities and lines, and a new steam generating plant went on stream at The Texas Company's Wilmington refinery in August to complete a $21,000,000 expansion program launched immediately after Pearl Harbor.

The new crude still unit is designed to run 12,000 bbl. per day of 36-42 API gravity crude, and consists of a pipestill furnace, a fractionating tower, and 2 strippers together with auxiliary coolers and condensers. The superfractionator addition is designed for processing 15,000 bbl. per day of charge composed of depropanized natural gasoline, straight-run naphtha, vapor recovery compressor gasoline, and any pentanes and lighter fractions from the refinery's alkylation unit. The fluid catalytic cracking unit is conventional and consists of a reactor, regenerator, precipitator, bubble tower, and fractionating equipment. The HF alkylation unit rounds out the expansion of processing facilities that, in sum total, have the effect of increasing the Wilmington refinery's crude oil processing capacity to 42,000 bbl. per day, and the production of more than 12,500 bbl. per day of 100-octane and secondary aviation gasolines.

Wilshire Oil Company. In December, 1943, the Wilshire Oil Company began construction of an 100-octane plant at its refinery at Norwalk, which was placed in operation during the spring. The program, doubling Wilshire's 100-octane output, included an isomerization unit, a fluid catalytic cracking unit, an HF alkylation plant, a complete laboratory, feed and finished product storage facilities, 2 boilers with a capacity of 250,000 lb. per hr. of superheated steam, and a turbo-generator consisting of three 1000-kva. generators, as well as a new 10,000 gal. per min. cooling tower.

Mohawk Petroleum Corporation. March witnessed completion of the Mohawk Petroleum Corporation's additions to its Bakersfield refinery, which involved the erection of a reformer, a gas concentration plant, an isopentane splitter, an HF alkylation plant, and an isomerization unit.

Natural gasoline developments. California's natural gasoline plants are now producing natural gasoline at the rate of 47,000,000 gal. per month, and liquefied petroleum gases at a rate exceeding 9,000,000 gal. per month, which represent substantial increases over the previous year's production.

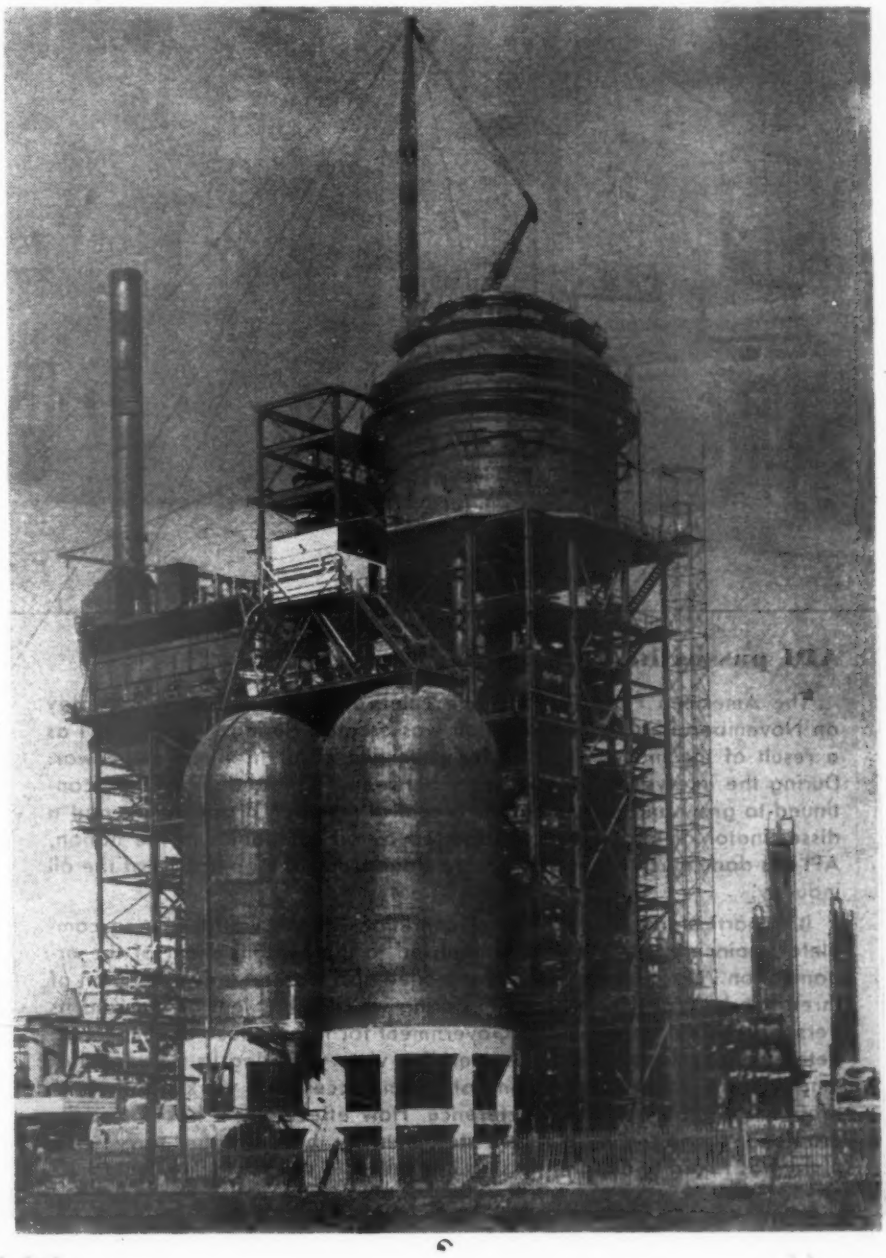
The most significant development in California's natural gasoline industry this year occurred on June 10 when the state's first cycling plant was placed on stream in the Paloma field southwest of Bakersfield. Likewise, the Paloma plant is the first in the state to be built and operated under the unit plan, the unitized area comprising 2800 acres at the time operations began. The Paloma field is still being developed, and some outlying black oil production is now included within the plan. The plant is now processing approximately 50,000,000 cu. ft. of gas per day from the Paloma sand section found at a depth of approximately 10,000 ft. The producing pressure of the wells varies from 2200 to 3000 lb. per sq. in. This pressure is reduced to 2000 lb. absorber pressure, and after recovery of the desired hydrocarbons, the dry residue gas is compressed and returned to the sand at a pressure of 4300 lb. per sq. in. The compressor installation totals 3600 hp. The plant is operated by Western Gulf Oil Company. Other participating companies include The Texas Company, the Ohio Oil Company, Union Oil Company of California, General Petroleum Corporation, and the Barnsdall Oil Company.

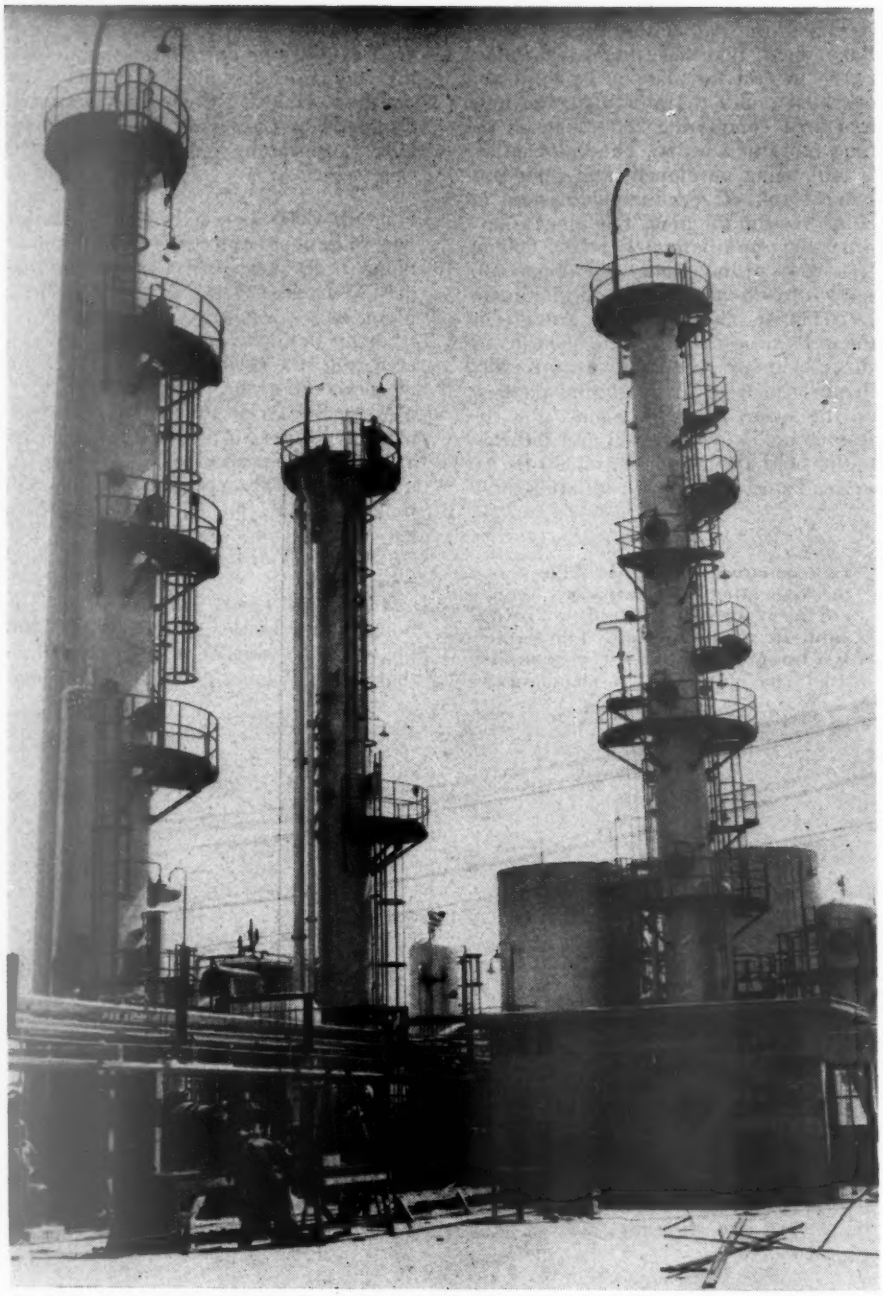
South Coles Levee. During the latter part of September ground was broken at South Coles Levee for the construction of California's second unit plan cycling plant, which will process 50,000,000 cu. ft. of gas per day from the field's gas cap area, and 10,000,000 cu. ft. per day from the black oil area.

Wet gas, at a producing well pressure of 3000 lb. per sq. in., will be received at the plant, reduced to 1500 lb. per sq. in. for 3-stage absorption at 1500 bl., 450 lb., and 175 lb. per sq. in. Residue dry gas will be compressed to 4000 lb. per sq. in. and returned to the producing zone.

The compressor installation at the South Coles Levee unit will total 5400 hp., which is considerably greater than that at the Paloma plant, the additional

Construction scene at the Tide Water Associated Oil Company's Avon refinery showing the new fluid catalytic cracking unit. The catalyst hoppers are in the foreground and the reactor in the rear.





Side view of the Union Oil Company's new Unisol plant.

hp. being required due to the fact that low pressure gas from the black oil zone is being treated at South Coles Levee. The Ohio Oil Company is operator of the plant, and the other participating companies are Standard Oil Company of California, Richfield Oil Corporation, Union Oil Company of California, and Tide Water Associated Oil Company.

▸ **Union at Santa Maria.** In the Santa Maria field, the Union Oil Company of California placed its new absorption and compressor plant in operation in mid-year. It is the only plant in this field and, at present, is processing 18,000,000 cu. ft. of gas per day at an absorber pressure of 190 lb. per sq. in. gage and a lean oil circulation rate of 16,000 gal. per hr. The plant is extracting 80 per cent of the isobutane content, 97.5 per cent of the n-butane, and 99.2 per cent of the pentanes and heavier. It was constructed largely of used and reclaimed equipment.

▸ **Tide Water Associated at Ventura.** Tide Water Associated Oil Company is increasing its natural gasoline plant facilities at Ventura to take care of the increased gas production resulting from increased crude oil production. The company now operates 3 plants in Ventura. No additions are planned for one of these plants, but a 400 lb. per sq. in. absorber, a depropanizer, a fat oil still, and deisobutanizer will be installed in one of the remaining plants and the compressor capacity of the third will be increased, 175 lb. per sq. in. absorbers added, and the cooling tower extended.

▸ **Shell Oil Company.** Also at Ventura, the Shell Oil Company, Inc., is increasing the capacity of its absorption plant from 65,000,000 cu. ft. per day to handle 95,000,000 cu. ft. per day. This plant is unique in that, through an arrangement with Pacific Lighting Corporation and Southern California Gas Company, Shell's absorbers are installed on the discharge side of their respective stations, and the normal procedure is reversed. Instead of delivery of dry gas to the utilities, in this instance the utilities deliver wet gas to the processor.

The expansion program calls for the addition of 2 absorbers, an additional 900-hp. compressor capacity, 1000 hp. boilers, pumping and distillation equipment. The plant will extract 90 per cent of the isobutane from 90,000,000 cu. ft. per day of gas to be processed.

Shell also is increasing the capacity of its 10 Sections absorption plant from 40,000,000 cu. ft. of gas per day to 60,000,000 cu. ft. per day with 90 per cent efficiency on isobutane recovery. Additions include a new absorber, depropanizer, isobutane splitter, propane purification facilities to handle 25,000 gal. per day, an extension of the cooling tower, propane storage for 50,000 gal., and tank car and truck loading facilities.

★ ★ ★

API passes its 25th anniversary

The American Petroleum Institute celebrated its twenty-fifth birthday on November 15. The organization was created during World War I as a result of the industry's need for collective effort in winning the war. During the intervening peace years between 1919 and 1941, API continued to grow and to function as a central research organization and a disseminator of information. Supported by oil companies in the nation, API has done much to simplify and to standardize the operation of the oil industry.

It is particularly significant that conditions of the world now so completely coincide with the factors that led to the establishment of the organization 25 years ago. The silver jubilee also marked the completion of three World War II years for API during which it has lent its aid and its personnel to the United States Government for the purpose of simplifying petroleum regulations and thus speeding victory. During its 25-year lifetime API has proved that an industry can successfully work out its own problems without outside interference. How effectually it has solved its problems is attested by a recent statement by the army and navy, "No plane has failed to fly, and no ship has failed to sail for lack of oil."

TREATMENT OF MUD WITH ORGANIC COLLOID

By **WALLACE A. SAWDON,** *Pacific Coast Editor*

EXCLUSIVE THE successful completion of a well under certain adverse subsurface conditions will frequently depend on the drilling mud employed. It is not always realized, however, that the use of better mud may quite often result in drilling economy, in a better cementing job, and in prevention of formation trouble. The necessity for weighted mud to protect against the effects of high pressures is universally recognized; but whether the mud is heavy or not it must have other properties if it is to be effective as a drilling fluid. Low water loss is one of the most important of these properties and the use of an organic colloid[1] to reduce the water loss to a desired minimum that can approach zero if necessary is discussed in this article. A drilling mud that has such an extremely low water loss is obviously desirable for drilling through productive zones, particularly low-pressure sands. Oil base drilling fluids also offer distinctive advantages in drilling through productive formations but this discussion is confined to water base muds treated with an organic colloid to obtain low water loss for various drilling conditions.

The best mud for any particular drilling operation must, of course, have desirable characteristics other than proper weight and low water loss. Chief among these to be considered are wall-building properties, viscosity, gel strength, and hydrogen-ion concentration or pH. Except for the wall-building qualities, which should always be the highest possible (i.e., the lowest water loss and thinnest cake), these characteristics may vary within limits and can be controlled to the desired degree by the use of chemicals, by dilution, by increased concentration of admixtures, or by combination treatment.

In a properly prepared mud, good wall-building properties will accompany low water loss. A mud with good wall-building properties is one that will form a highly impervious mud cake on the wall of the hole and, as the cake is a deposition of solids remaining after infiltration of water into the formation, the less the water loss the thinner will be the cake. A.P.I. water losses[2] as low as 8 or 9 cc. have been obtained by the addition to the drilling mud of prepared bentonite with suitable chemicals but there are conditions where water losses lower than that are necessary. By high concentrations of the organic colloid water losses of less than 1 cc. have been obtained.

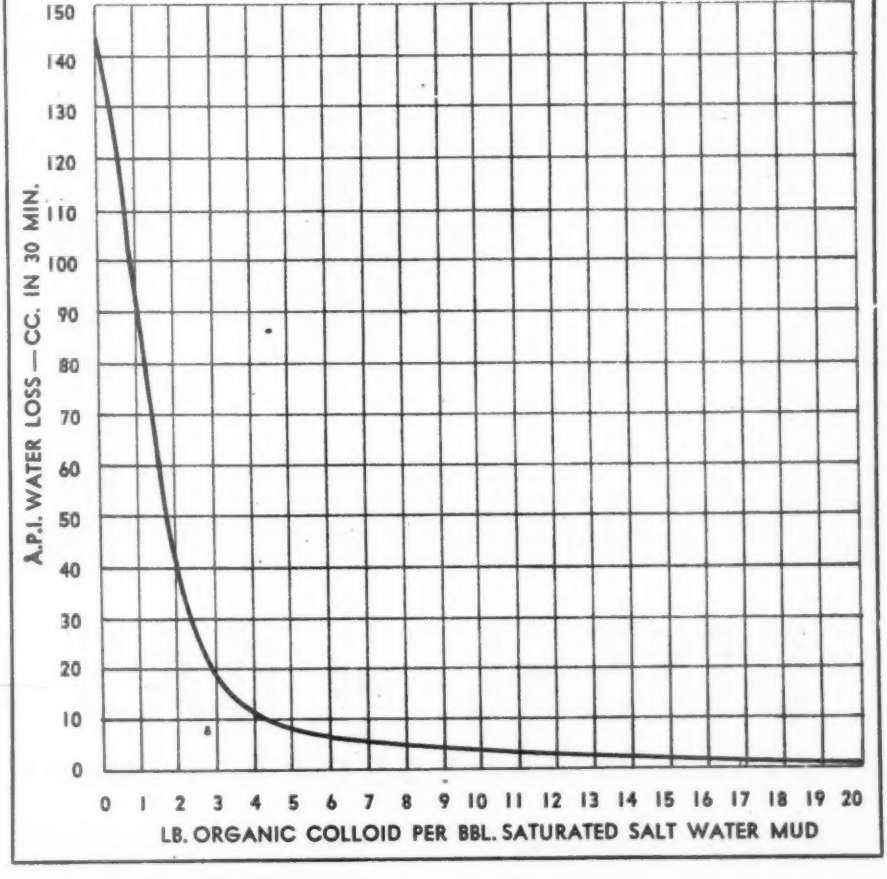
The use of this organic colloid in a drilling mud is not only a means of reducing water loss to a minimum but is also believed to be the most practical method known at the present time for reducing the high filtration characteristics of a drilling fluid that has been contaminated with salts, such as sodium, magnesium or calcium chlorides, sulphides, cement, or, as occasionally happens, acid. The characteristics imparted to the mud by the organic colloid have provided (in addition to meeting general drilling problems that require low-water-loss muds for their solution) for drilling through caving formations or those formations that ordinarily become dispersed in the mud stream when customarily used muds are employed; for continued use of the same mud after penetrating a flow of salt water or water otherwise contaminated; for drilling through productive zones with minimum infiltration of water into the formation, and for utilizing sea water or other salt water sources as mixing water for the mud. The decrease in water loss from a saturated salt-water mud with increased concentration of the organic colloid is shown graphically in Fig. 1.

A method to reduce water loss to a minimum and to provide for use of contaminated drilling fluids.

The thinness of filter cake is too highly appreciated to require much discussion. A thick cake may be scraped off entirely when running the drill pipe and bit in and out of the hole and the sealing effect of the mud is thus frequently lost,

(Continued on Page 70)

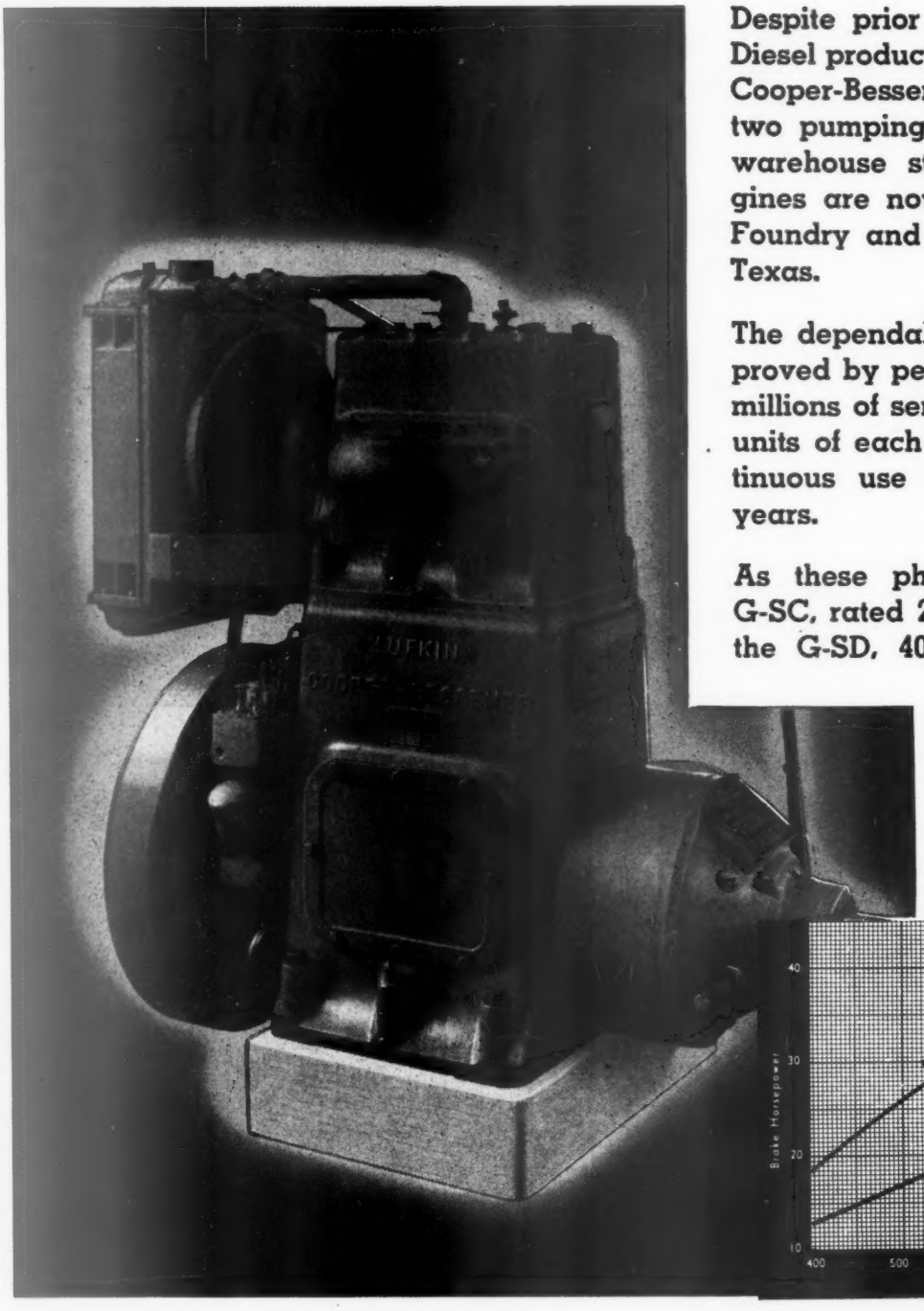
FIG. 1



[1]The organic colloid upon the use of which this article is based is supplied under the trade name "Impermex" by Baroid Sales Division.

[2]The A.P.I. water loss is the throughput of filtrate in cc. in 30 min. when using a 3-in. filter cell operated at a pressure of 100 lb. per sq. in. and temperature of 80°F.

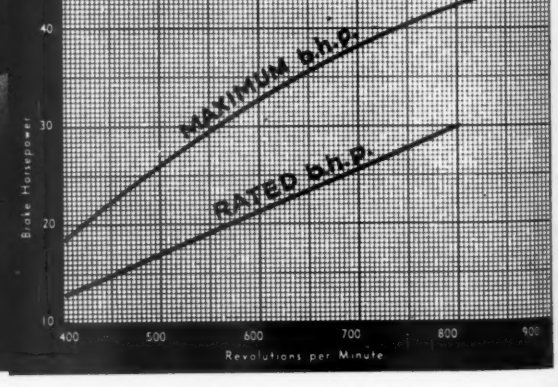
G-SC and G-SD engines



Despite prior commitments and peak Diesel production for the armed forces, Cooper-Bessemer can deliver these two pumping engines promptly from warehouse stock, because both engines are now being built by Lufkin Foundry and Machine Co., at Lufkin, Texas.

The dependability of these engines is proved by performance totaling many millions of service hours. Hundreds of units of each type have been in continuous use for as much as seven years.

As these photographs indicate, the G-SC, rated 25 to 35 horsepower, and the G-SD, 40 to 60 horsepower, are



CURVE A—Maximum Brake Horsepower Developed by type G-SC gas engine. CURVE B—Recommended rating for continuous full load operation with radiator and air filter.

DIESEL AND GAS ENGINES

FOR COMPRESSORS, PUMPS, GENERATORS

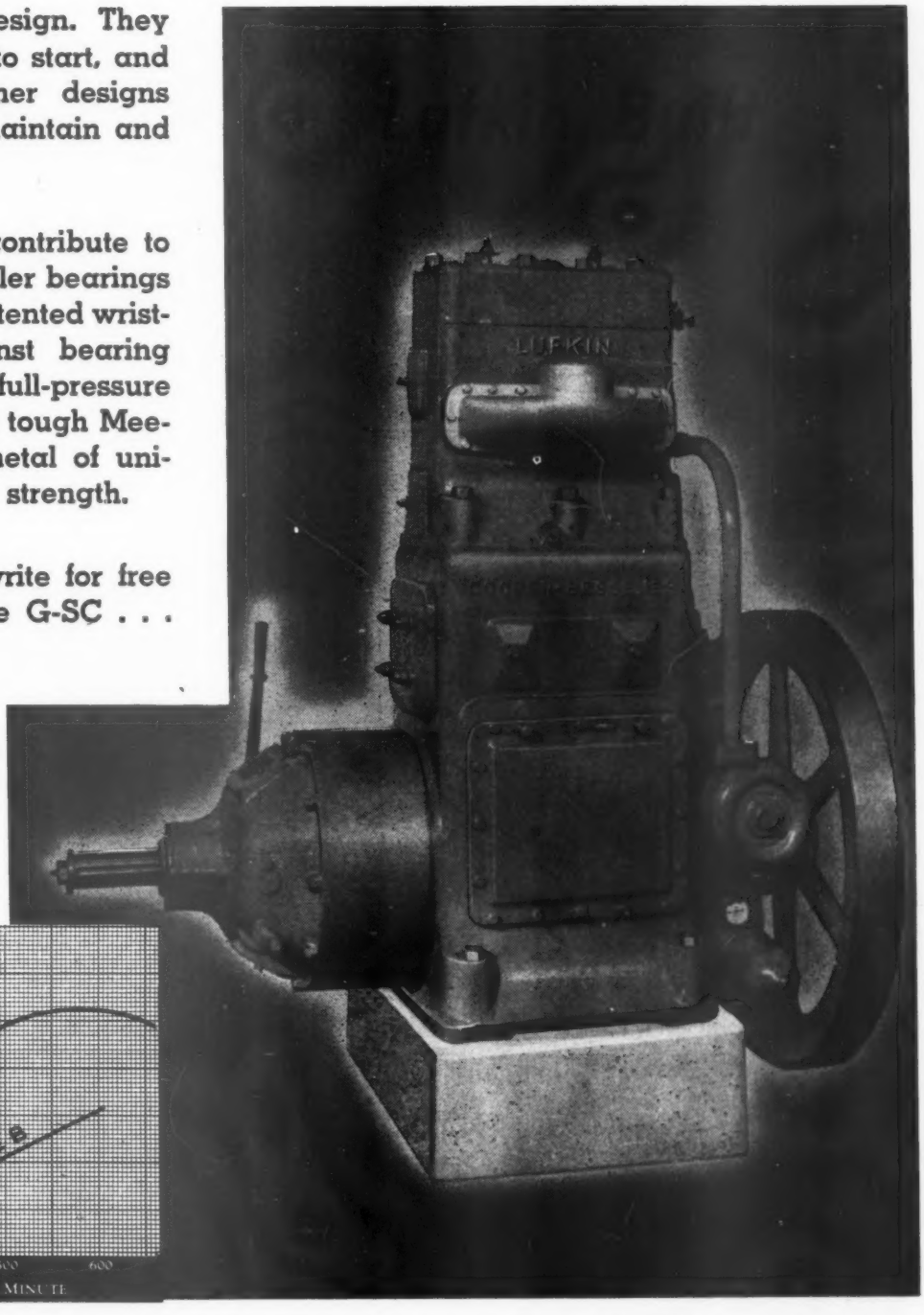
New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wash.

to meet your pumping needs

compact and simple in design. They are light in weight, easy to start, and like other Cooper-Bessemer designs they are economical to maintain and operate.

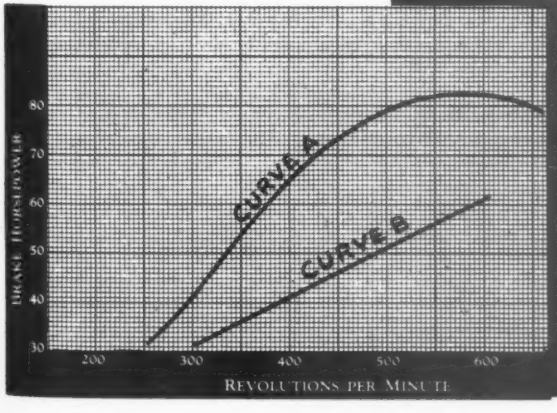
Certain special features contribute to their long life. Tapered roller bearings and Cooper-Bessemer's patented wrist-pin design protect against bearing failure. Lubrication is full-pressure type. All cast parts are of tough Meehanite, a close-grained metal of uniform quality and unusual strength.

For further information, write for free bulletins — No. 326 for the G-SC . . . No. 303 for the G-SD.



CURVE A — Maximum Brake Horsepower developed by 7½" x 9" type G-SD gas engine in actual test.

CURVE B — Recommended Rating for full load operation.



by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Houston, Dallas, Greggton, Pampa and Odessa, Texas Tulsa Shreveport St. Louis Los Angeles

(Continued from Page 67)

any hazard of caving or sloughing being repeated at each round trip. The replacement of the cake and its growth while drilling between trips is thus important. This growth of the cake is dependent primarily upon its permeability, which is reflected not by water loss alone but by both water loss and cake thickness simultaneously. A thick cake will have a proportionately higher permeability than a thin cake for the same test, even though the water losses of the two muds may be the same. With a mud having the thin cake and low-water-loss characteristics provided by the organic colloid admixture, the additional cake built up between trips is scarcely measurable.

Laboratory tests made with various muds treated with the organic colloid have been used to determine the water-loss and wall-building characteristics of the resulting fluids. In one test made with a clay mud that was contaminated with salt, the filtrate was 98 cc. and the cake thickness 2¼ in. This mud was then partially treated with the organic colloid and the filtrate was found to be 8 cc. with a cake thickness of 5/32 in. When thoroughly treated with the organic colloid the same mud had a filtrate of 0.6 cc. and a cake thickness of 1/128 in.

Another feature disclosed by laboratroy tests is the ease of maintenance of the treated mud when drilling through mud-making formations. This property arises from its ability to keep shale cuttings from hydrating and disintegrating. A shale was shaken in contact with a typical freshwater mud and then screened. Much of the shale passed through the screen and was dispersed in the mud fluid. The shale was then shaken in contact with the same mud after it had been contaminated with salt. The shale in this case broke up completely. The shale was finally shaken in contact with the salt-contaminated mud after it was treated with the organic colloid. The result of this test was freedom from disintegration with most of the shale remaining in its original condition. This characteristic is, of course, advantageous when drilling through heaving, caving, or swelling shales, particularly when the fluid becomes contaminated with salt water. It is even possible with such mud to drill through quite plastic shale and still have all the cuttings thrown out by the shaker and in substantially their original size instead of having them dispersed to make unwanted mud.

This test on salt-contaminated mud thoroughly treated with the organic colloid showed an A.P.I. water loss of 0.6 cc. and a cake thickness of 1/128 in.

FIG. 2

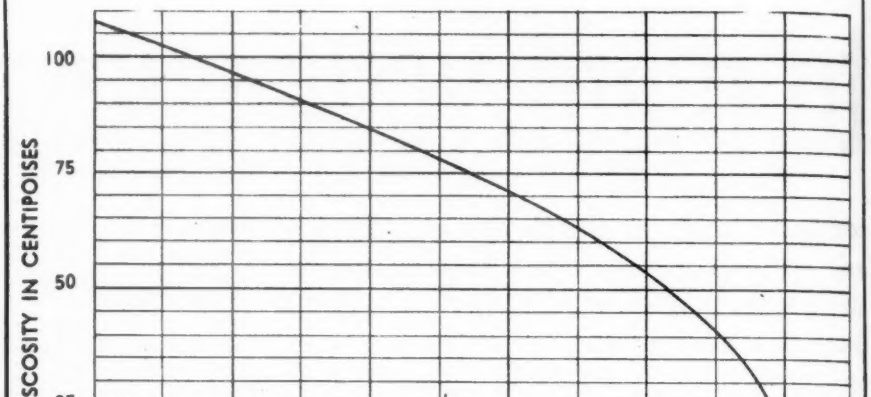
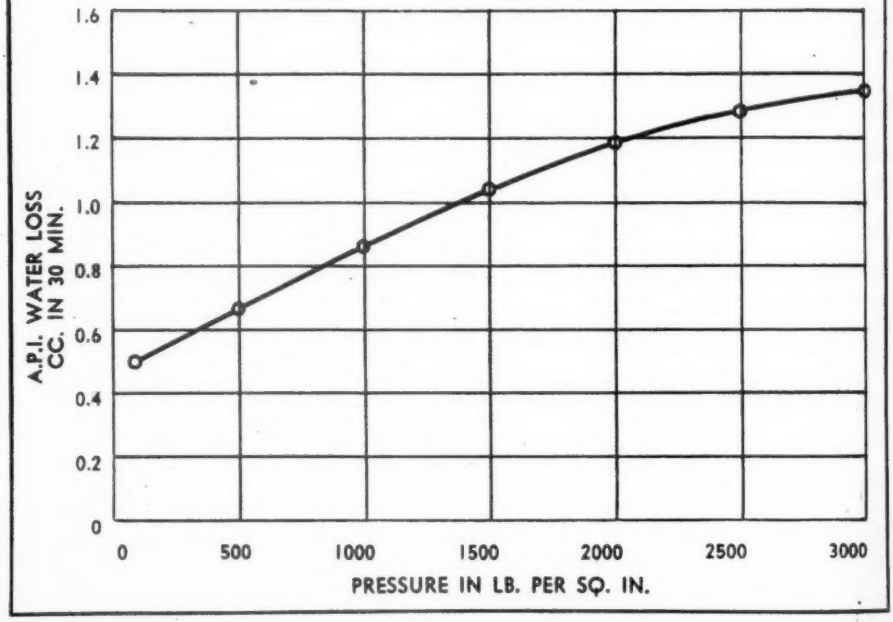


FIG. 3



▸ **Treatment of mud with organic colloid.** The organic colloid is of the hydrophilic type and when it is to be used for treatment of a drilling fluid provision must first be made to make certain that there is no possibility of decomposition (as from fermentation, bacterial degradation, etc.), and that the base mud is in suitable condition or can be adequately modified to prevent excessive viscosity that may result from the increase of viscosity that generally accompanies the addition of the colloid to the mud. When the base mud has a relatively high concentration of salt it is frequently possible to add the material without any precautions being taken against decomposition. It is possible that a fresh-water mud may be free from inoculation by destructive organisms, which may be absent from the clay and water of which the mud is made and from the formation penetrated, but these circumstances are exceptional and such sterile conditions cannot be counted upon.

(Continued on Page 75)

(Continued from Page 70)

Decomposition of muds treated with the organic colloid can be inhibited by (1) the use of salt at concentrations not less than 20 per cent by weight of the fluid phase of the mud, and (2) the maintenance of the mud at a pH[3] of approximately 12. Decomposition can be prevented by the use of chemical bactericides, fungicides, and anti-fermentatives, but because chemical bactericides affording enduring protection against decompotion of the treated mud are still in the development stage at the present time, its use will not be discussed.

When salt is encountered during drilling or where the water with which the mud is mixed contains salt in sufficient concentration, the organic colloid can be introduced without preparation for microbiological inhibition. The concentration must, however, be near saturation and must be kept at 20 per cent or higher; that is, at 20 grams per 100 cc. filtrate, 200,000 parts per million, or 12,000 grains per gal. If the salt falls below that concentration it becomes necessary to add salt to the treated mud. When large amounts of salt must be purchased for this purpose it usually becomes not only more economical but also more satisfactory as far as results are concerned to prevent decomposition of the mud fluid by maintaining a high pH.

▸ **Preparation for treatment.** Before adding the organic colloid to the mud fluid the pH must be raised to approximately 12. This is done by the addition of one or more alkalizing agents, such as caustic soda, in the manner usually employed with other chemical treating agents. The amount of alkali naturally varies widely and depends on the original pH of the fluid being treated, the total base exchange capacity of the clay minerals contained, the presence of cement (if any), and other contents of the mud, which may be complex when a contaminated drilling fluid is being treated. In general, the amounts of alkali necessary for preparation will range from ½ to 4 lb. per bbl. of drilling mud. The exact amount needed can be estimated closely by a pilot test on a mud sample taken in advance of treatment. To prevent formation of clumps of thickened mud formed before the alkali becomes distributed it is advisable to inject the alkali downstream from the shaker screen.

The entire volume of the mud in the circulating system must, of course, be brought up to the desired pH of at least 12 before the organic colloid is added in order to make sure that all the mud is sterilized prior to the introduction of any fermentable material. Where it is possible to do so, several hours should elapse after the pH has been brought up to 12 before adding the organic colloid.

The addition of the alkali to the mud and the later addition of the organic colloid cause initial temporary changes in the characteristics of the fluid that are often in the opposite direction to the permanent trend. This should be kept in mind when making pilot tests at the well or in the laboratory; and before any conclusions are drawn on the effect of the additions on any given mud, the fluid should be agitated after the additions are made to a much more thorough extent than is ordinarily done when the additives are such relatively inert materials as clay or weight material. When the alkali and the organic colloid are introduced into the mud stream at a well the first returns may be thicker than anticipated but, in general, a state of equilibrium will result after circulating for two or three hours.

The technique developed for the treatment of mud with the organic colloid provides for control of viscosity for any concentration of the material added, as well as for inhibition of fermentation. The viscosity control is based on the behavior of mud fluids containing the organic colloid when at a very high pH, and under these conditions the additive appears to act as a protective colloid to a very high degree, decreasing the gels of the mud and bringing about a general reduction of consistency. The relationship of the viscosity and pH of one mud treated with the organic colloid is shown in Fig. 2. Many clays, however, have their viscosities raised by an increase in the pH and when the mud is made with such clays means must be taken to offset this influence on viscosity in order to make the treated mud most effective. Fortunately the high pH range at which low viscosity is attained is the same range over which fermentation and bacterial action can best be controlled and the full effect of the organic colloid on reduction of water loss to the degree desired can be obtained without impairing the other qualities of the mud fluid.

▸ **Maintenance of treated mud fluid.** After the mud has been treated it should be checked several times each tour during the first day or two and at least daily thereafter for as long as the fluid is in service. The pH must be kept at a safe value by adding alkali as necessary, usually only a fraction of a pound per barrel daily. To maintain a specified water loss it will also be necessary to make additions of the organic colloid from time to time and tests should be made regularly to determine the properties of the mud so that it can be kept in proper condition. Additions of the colloid are usually small in amount and are generally necessary only every three or four days to keep the water loss constant. Control of the fluid depends upon a wide variety of individual well conditions and is influenced by mud temperature, degree of agitation, and similar factors. Treated mud stored in a tank should be agitated at least daily and the required amount of alkali added to maintain the pH at 12 or slightly above.

▸ **Other properties of treated mud.** Although the chief purpose of treating a fluid with the organic colloid is to obtain a minimum water loss with any type of mud in use or to provide for the continued use of contaminated mud, other properties must be maintained. Experience has shown that mud so treated will retain a low filtrate value at high temperatures such as those encountered at the bottom of a well. The effect of pressure has been determined by tests, the results on one of which are given graphically in Fig. 3. This test was made on mud taken from a drilling well, the filtration being measured at 500 lb. per sq. in. intervals up to 3000 lb. per sq. in.

Base muds vary so widely that it is obviously impossible to establish any rule for treating the fluid. All the graphs here presented have therefore been compiled from tests made on particular muds actually used in the field. The curve given in Fig. 1 is an approximate average of water loss for different concentrations of the organic colloid. Tests at different concentrations were made on a mud in service in a certain well to determine the water loss, viscosity, initial gel strength, and 10-min. gel strength of the fluid, when treated with various amounts of the organic colloid up to 13 lb. per bbl. In preparing this particular mud the pH was first raised to 12.5 with a chemical without greatly changing the viscosity or other physical properties. The tests disclosed that the initial gel remained at a low value at all concentrations of the additive and thus indicated that the mud would clean up and release entrained gas very readily. The 10-min. gel at no point reached a value that would cause difficulty in reestablishing circulation. The viscosity did not limit the water loss and when the treatment gave a water loss as low as 1 cc. API the mud was fluid and workable.

The mud of the character shown by these tests approaches the truly viscous condition with the type of viscosity associated with lubricating oils, glycerin, or sugar solutions. Mud of this kind with a Stormer viscosity as high as 80 or 100 centipoises will pump and flow with the ease of an untreated mud having a viscosity little greater than water. A straight clay-water mud is considered unpumpable at approximately 60 centipoises.

It has been found that the viscosity and gel strength of muds treated with the organic colloid can be controlled as closely as can those of muds treated with chemicals and prepared bentonite. Weight material is used to weight the mud in the same manner as with other treated or untreated muds.

▸ **Use of mud treated with the organic colloid.** This type of treatment has been employed for meeting a great variety of problems, the solutions being based essentially on reduction of water loss. Brief outlines to indicate the scope of treatment and details of particular jobs will be presented in a later issue to show the application of the technique developed.

★ ★ ★

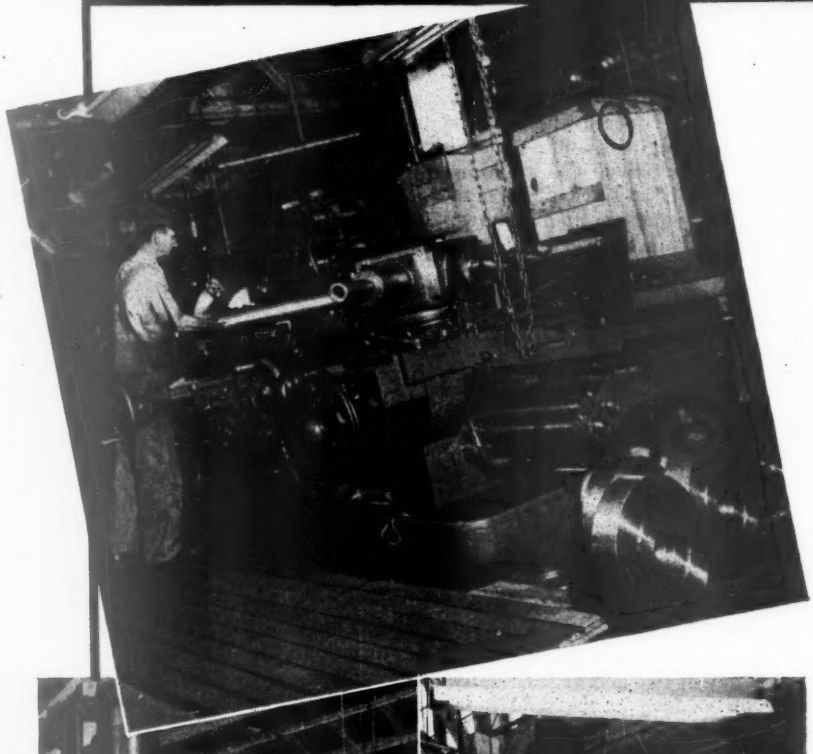
[3]The term pH denotes the degree of alkalinity or acidity possessed by a substance. The scale extends from slightly below 1 to slightly above 14, the neutral point being the middle, or 7. Thus a pH above 7 would be on the alkaline side and a pH below 7 would be on the acid side. The basis of pH determination is the hydrogen-ion concentration, pH being the logarithm of the reciprocal concentration in moles per liter.

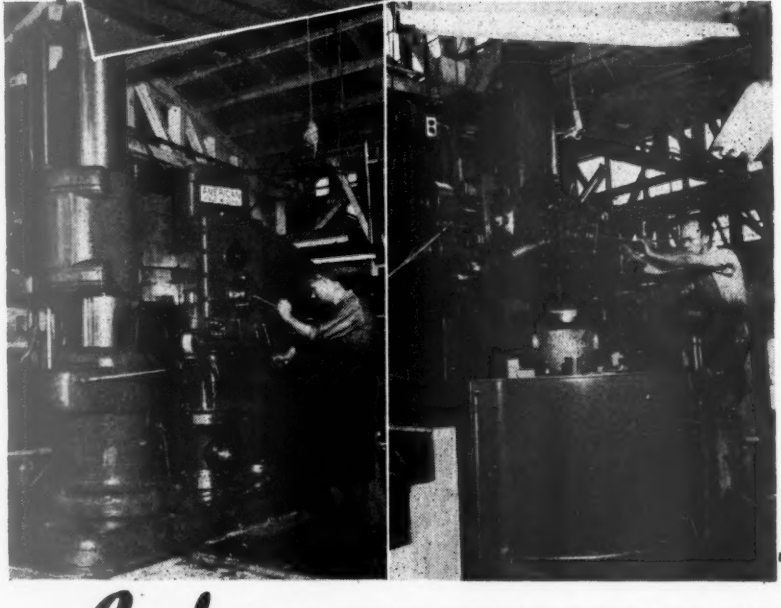
For the Second Time
McEvoy Company Wins
The Army-Navy
Production Award

"... the Symbol of appreciation for CONTINUED

Continued and determined efforts in war-essential oil equipment manufacturing

McEVOY INSTALLS FINEST MANUFACTURING EQUIPMENT





In line with its policy, "Advanced tools demand advanced manufacturing methods," the McEvoy Company has added to the machinery used in the war work that won the "E" Flag and the Star in the "E" Flag, the finest machines that can be bought in order to make advanced tools for the war-essential oil industry.

McEvoy quality-inspection control: Correct practices using the most modern scientific control equipment, assures all McEvoy products getting a thorough, rigid, and double-tough inspection.

McEvoy precision manufacturing assures perfect interchangeability — eliminating misfits, saving time, and avoiding costly trouble on the lease.

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Look TO THE PROVED RESOURCEFULNESS OF McEVOY COMPANY FOR A LINE OF BETTER DESIGNED AND BETTER MADE OIL FIELD TOOLS TO BE ADDED TO McEVOY'S PRESENT LINE.

D *and* DETERMINED EFFORT"

THERE are machine gun mounts on Leyte, airplane landing struts in Belgium, tools of war wherever our armed forces fight today —made by McEvoy workers and McEvoy machines. That is our part in the war effort. The star in our Army-Navy "E" flag awarded us November 4th by the War Department for "continued and determined effort and patriotism" is a source of deep pride to the men and women of the McEvoy Company. It renews our determination to keep on the job, to beat the promise to merit the thanks of the men who fight for us.

WAR DEPARTMENT
OFFICE OF THE UNDER SECRETARY
WASHINGTON 25, D. C.

14 October 1944

To the Men and Women
of the McEvoy Company
600 Milby Street
Houston, Texas

I am pleased to inform you that you have won for the second time the Army-Navy Production Award for meritorious services on the production front.

You have continued to maintain the high standard and which you set for yourselves and which won you distinction more than six months ago. You may well be proud of your achievement.

The White Star, which the renewal adds to your Army-Navy Production Award flag, is the symbol of appreciation from our Armed Forces for your continued and determined effort and patriotism.

Sincerely yours,

Robert P. Patterson
Under Secretary of War

McEVOY COMPANY
OIL WELL EQUIPMENT
HOUSTON, TEXAS
October 19, 1944

Honorable Robert P. Patterson
Under Secretary of War
War Department
Washington, D. C.

Dear Mr. Patterson:

The War Department's recognition of the work done by the Men and Women of McEvoy Company will make us strive the harder to aid in winning the war.

We are proud of the White Star. We want to continue to merit this award so that, in the years to come, we shall have no regrets about the part we played in the greatest event in history.

Some are called on to die, and some are called on to work for their country. Our assignment is work - we will not let you down!

Sincerely yours,

Gus S. Wortham, President

GSW:dc

McEvoy COMPANY

GUS S. WORTHAM, President
GEORGE A. BUTLER, Counsel
B. T. McNEIL, Vice-President
W. O. HEDRICK, Vice-President
J. C. REBMAN, Secretary and Treasurer

P 622.32

PIPE LINE WELDING*

By **M. A. HARDIE, SR.**, Glacier Production Company
Gas Production Superintendent

SINCE the advent of welded pipe lines, some 20 years ago, there have been many improvements of methods and procedures. The first solid welded lines were not considered generally successful until arc welding came into the picture in a large way.

The author of this paper attempts to cover some of the troubles encountered in the joining of two or more joints or sections of pipe into one solid line.

Plain end pipe was used with ends beveled and is still being used. It was found that in some cases faulty welds occurred due to such causes as too little or too much penetration of metal. The former causing a weak weld and the latter an uneven inner surface of the pipe line. Sometimes metal was burned through far enough to cause the stoppage of scrapers in oil lines and lines had to be cut to remove a scraper.

Also in gas lines, particularly in field gathering lines, some welds occasionally burned in so deep as to cause interior roughness with the resulting tendency to cause freezing and sometimes complete stoppage where hydrates were present in the right proportions, and under the right conditions to hasten freezing.

As a means to strengthen joints, the "chill ring" was put into quite general use. Several kinds of chill rings were used. These rings of metal were inserted in the ends of joints to be welded and the weld was burned down to the chill ring. This method made a strong joint; however, in order to keep the inside diameter of the pipe the same, the ends of the joints were upset to accommodate the ring that had the same internal diameter as the pipe.

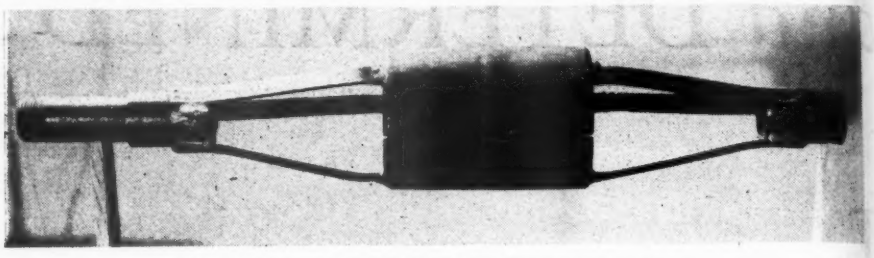
Here again, it was found that although the chill ring made a good joint, the unevenness in each joint caused by the upset ends and ring combined sometimes caused freezing troubles.

The author of this paper began experiments to obtain a good solid weld where internal smoothness would be assured without the use of the chill ring and upset ends of pipes. After considerable experimenting a segmental copper mandrel was developed and put into general use by the Glacier Production Company and The Montana Power Company in their Cut Bank, Montana, gas field.

By the use of the mandrel shown in the accompanying photograph the use of chill rings and upset pipe ends was done away with entirely.

The use of the mandrel is simple. It is inserted half way in the end of the first joint to be welded. A length of ½-in. pipe 2 ft. longer than the joints of pipe is run through the next joint and screwed to the threaded nipple shown in the illustration. The joint is then placed in line on the protruding end of the mandrel leaving the proper space between ends of pipes for welding. After the first "pass" has been made the mandrel is then drawn through to the end of the joint being welded and left protruding as before and the next joint is lined up and made ready for welding while the first weld is being finished. No time is lost, the speed of the job being entirely up to the welder.

This method of pipe-line construction has been used by the writer only in gas and oil gathering lines on working pressures from 500 to 1200 lb. The cost on this particular construction varies a great deal owing to ground surface and other conditions, so that no great claim can be made so far as labor is concerned, and we have no figures available for comparison; however, it is safe to assume that a saving is made on labor.



Mandrel used in welded pipe line construction to eliminate use of chill rings and upset pipe ends.

The principal saving is on cost of chill rings and upsetting of the pipe at the mills.

Eight-inch pipe with upset ends end chill rings cost extra 60 cents per 100 lineal ft. in 50-ft. lengths; 4-in. pipe, 24 cents per 100 lineal ft. with chill rings and upset ends in 50-ft. lengths. The above are the only sizes on which the chill ring was used by us. Our savings therefore were 60 cents and 24 cents, respectively, for 8-in. and 4-in. sizes on each weld.

The mandrel is also used on 3-in. but that size pipe has always come with plain ends.

We get a perfectly smooth surface inside our lines. Scraper troubles in oil lines have been eliminated so far as rough joints are concerned and gas freeze-ups minimized in gas lines.

★ ★ ★

*From a paper submitted in the Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

AMERICAN COMPANIES SEEK OIL IN EGYPT

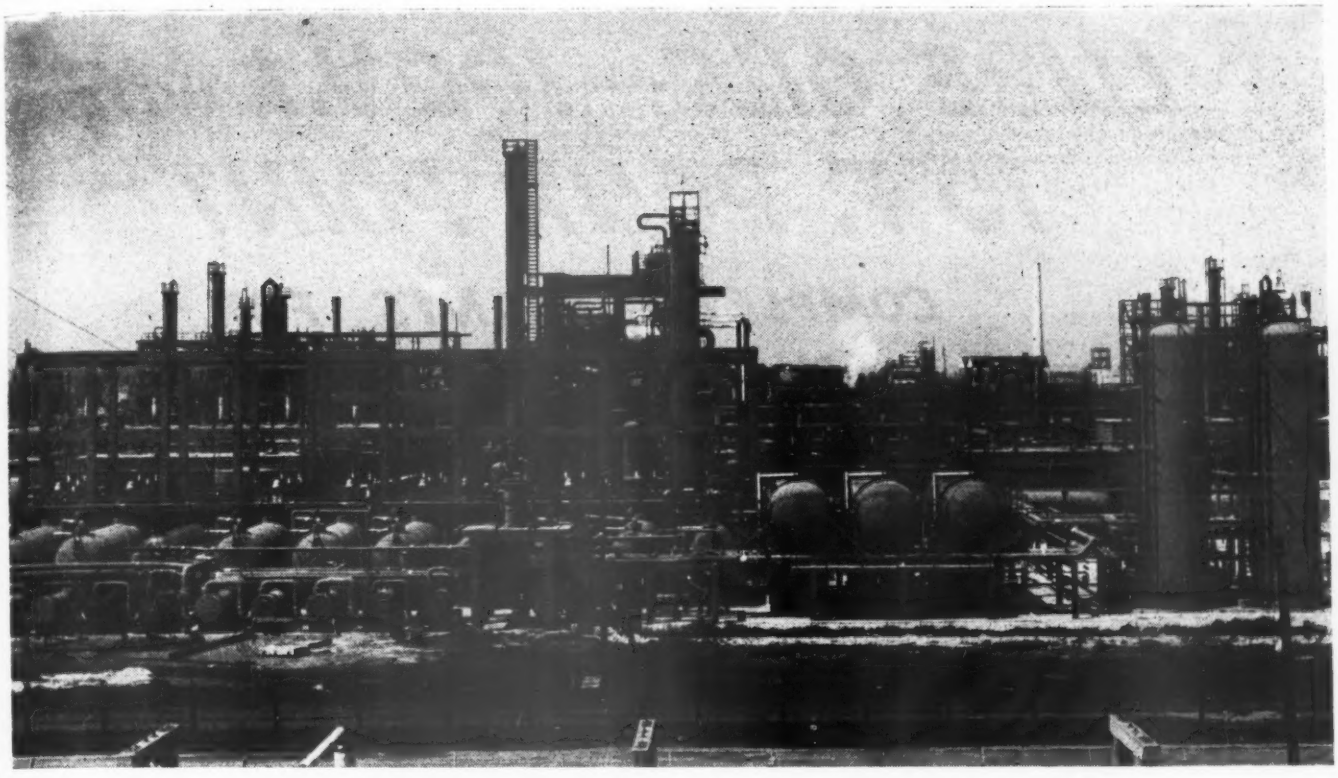
THREE American oil companies, holding exploration permits to a combined 18,000,000 acres of Egypt's desert land, have begun an extensive search for oil. The three companies, Standard of New Jersey, Socony-Vacuum, and Texas-California Standard, the latter an alliance, obtained their permits to drill for oil in 1938 and had begun preliminary work when Nazi General Rommel led his Afrika Korps in the invasion of Egypt. Activities were suspended, but now the companies are back on the job.

About ten miles from Egypt's great Sphinx of Giza, a drilling crew for the Standard of California and Texas companies has already drilled 3000 ft. in a search for petroleum. Standard of New Jersey is drilling a test well at Nekhl on the Sinai Peninsula and Socony-Vacuum's experts in desert oil drilling are on the scene to organize operations for that company. The three companies plan to spend a total of $15,000,000 within the next few years in what they already recognize as a long and costly job of desert wildcatting.

The American companies are latecomers on the scene for development of Egyptian oil resources. Output of oil is now about 10,000,000 bbl. a year with production centered in British hands. The first field, opened by Anglo-Egyptian Oilfields, Ltd., a British dominated company, was discovered in 1913. Present production in Egypt comes from the fields on the west bank of the Red Sea about 200 miles from the nearest refinery at Suez. Included in these fields are Hurghada, discovered in 1927, and the Ras Gharib, opened in 1938.

The first Egyptian field to reach commercial production was the now-exhausted Gemsah, discovered in 1911 and brought to production in 1913. Authorities say that it was exhausted from service for the Allies in World War I.

Under normal conditions, Egypt consumes petroleum products at approximately 6,000,000 bbl. yearly, thus leaving a surplus of 3,000,000 to 4,000,000 bbl. annually for exportation. Surpluses will increase as development progresses, authorities predict.



A section of the butadiene plant operated by Humble at Baytown, Texas. The chief raw materials for its use come from the company's refinery adjoining this plant.

1,000,000,000 GALLONS AVIATION GASOLINE PRODUCED

In a fitting ceremony at Baytown, Texas, employees of Humble Oil and Refining Company on December 14 commemorated a feat unparalleled in the petroleum industry—the production of one billion gallons of finished 100-octane aviation gasoline at the company's Baytown refinery.

This achievement climaxes a quarter of a century of research, planning, and development by the Humble organization, which in those 25 years has made uniform progress in every phase of its operations.

The war production record of the Humble companies in the 3 years since Pearl Harbor is an outstanding one, and the December 14 celebration served to spotlight the company's leadership in war operations and to pay tribute to its 14,000 employees. Here are some of Humble's war accomplishments:

Attainment of the billion gallon record in the manufacture of finished 100-octane gasoline gives Baytown refinery the distinction of being the first and only individual refinery to have produced this quantity.

Baytown Ordnance Works, the first plant in the nation to manufacture toluene from petroleum by chemical synthesis, has supplied the toluene for at least one out of every two bombs used by the United Nations since Pearl Harbor. For this achievement it has been awarded the Army-Navy E five times.

Humble refineries have also supplied very large quantities of other aviation and military gasolines, aviation engine and heavy duty lubricating oils, Navy special fuel oil, and other essential products. They are supplying about one-sixth of the materials being manufactured from petroleum for the critical synthetic rubber program.

Achievement by Humble Oil and Refining Company is commemorated by fitting ceremonies at Baytown, Texas, on December 14.

Humble is producing more crude oil than any other company in the United States. One-fourth of the additional crude oil needed for war is being produced by Humble, making its current production amount to 1 bbl. in every 12 of the domestic supply.

Humble Pipe Line Company is transporting approximately 700,000 bbl. of oil a day, which amounts to 1 in every 7 bbl. of the nation's supply.

Highlight of the December 14 celebration was the formal presentation of the one-billionth gallon of 100-octane aviation gasoline to a high ranking military official by H. C. Wiess, Humble president. In addition to military officials there were in attendance state and national government officials and leaders in industry.

To interest visitors to Baytown a number of special exhibits of war equipment were provided, each of which emphasized how dependent modern mobile armies and navies are on petroleum.

Additional exhibits and motion pictures portrayed Humble's operations and served to orient visitors before they inspected the Baytown refinery. Special tours were conducted through the refinery and adjacent war plants throughout the week of December 14.

The entire program for the celebra-

(Continued on Page 82)

LUBE OILS--100 V.I. with -10°F. POUR POINT

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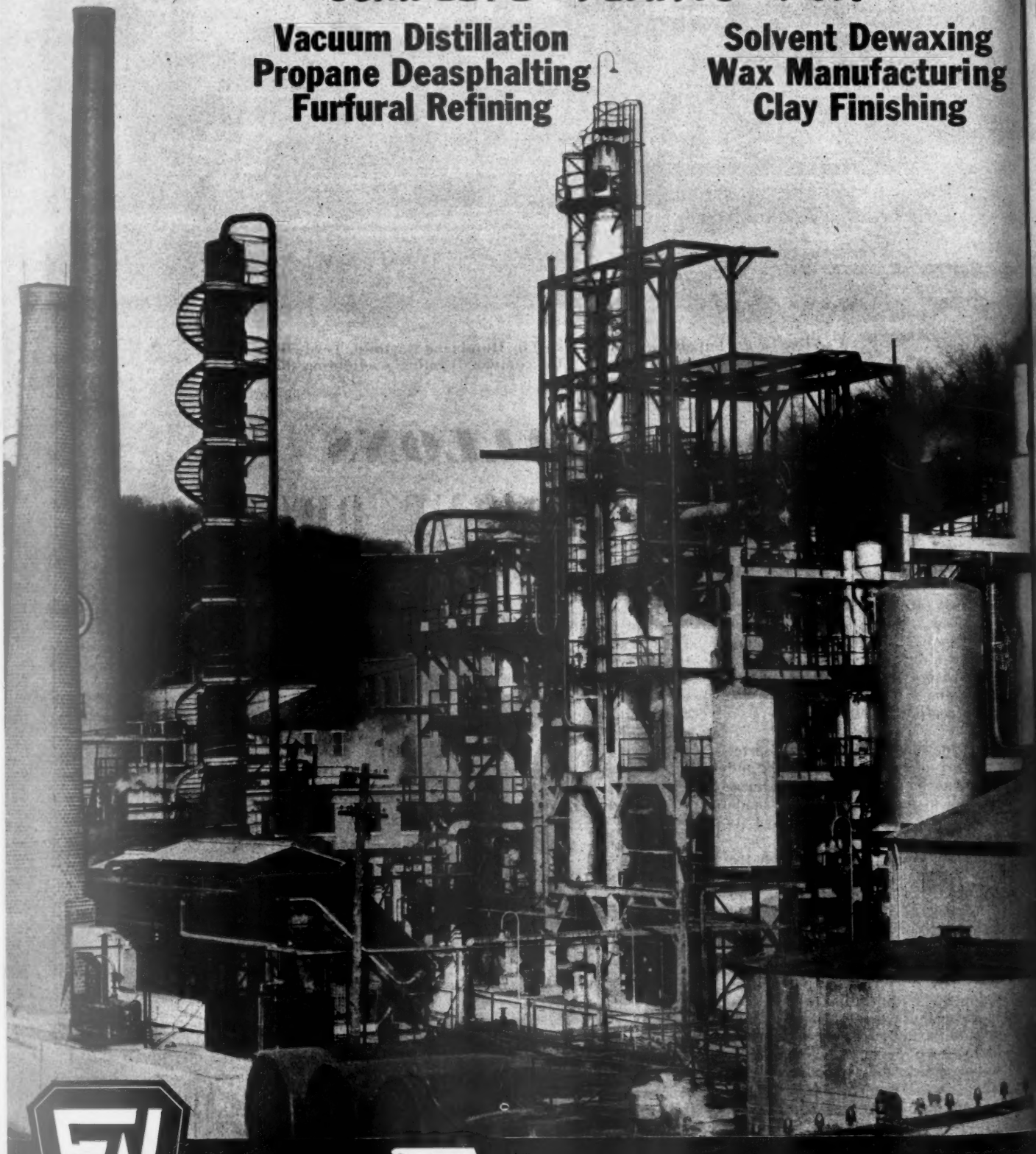

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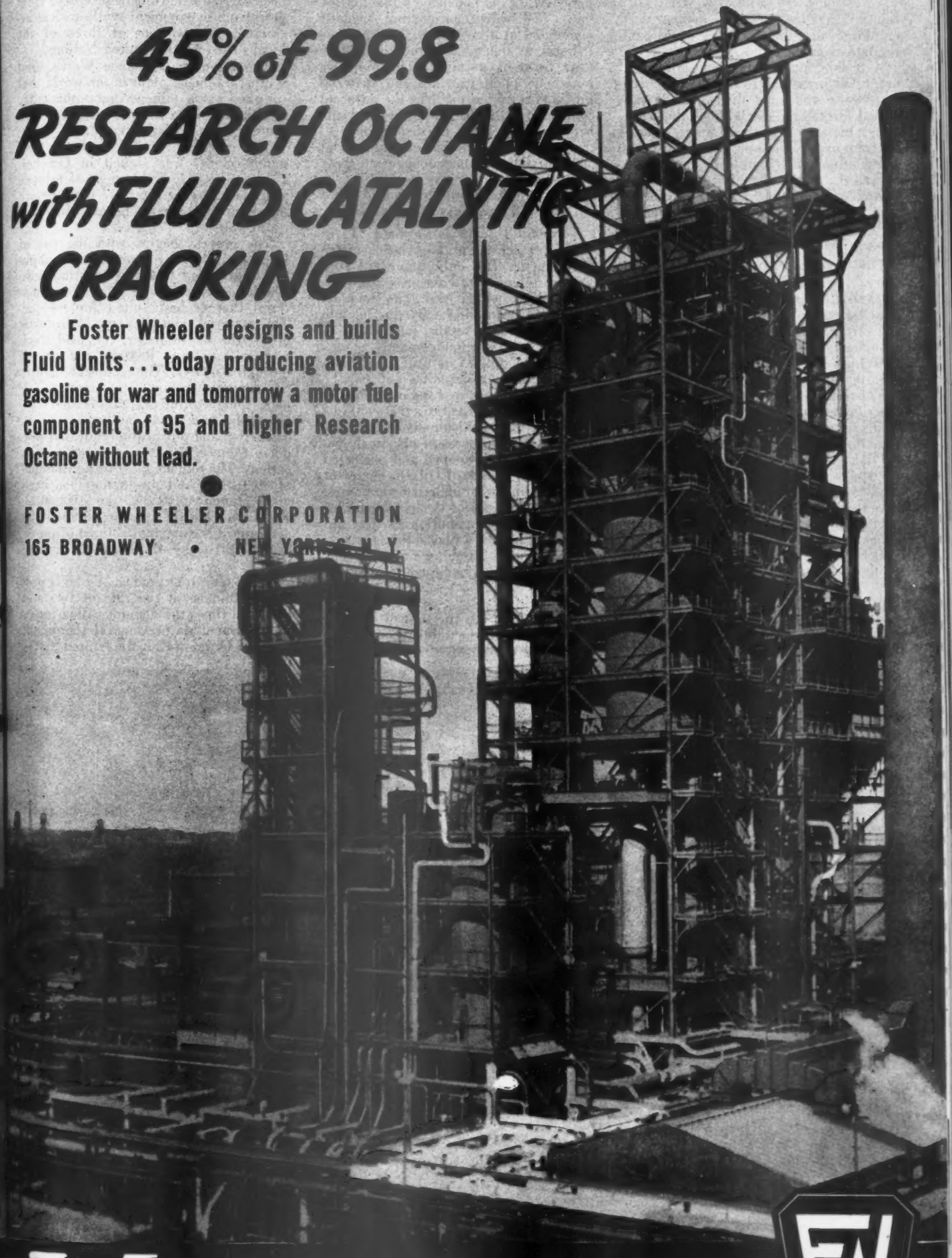


WHEELER

(Continued from Page 79)

tion was arranged in such a manner that employees and their families could participate as much as possible.

A bronze medal commemorating the event was presented to the 14,000 active employees, and more than 3,000 in the armed forces in a special book that contains a message from the company's management expressing appreciation for the contribution each employee has made toward the establishment of war production records. Another booklet, telling in pictures and story the accomplishments of the several departments of the companies, was mailed to each employee.

▸ **The Baytown refinery.** The Baytown refinery, owned and operated by Humble Oil and Refining Company, is situated on the Houston Ship Channel about 25 miles from Houston. The channel is deep enough for the largest tankers and the great bulk of products from the refinery is normally shipped by tanker.

The refinery is processing more than 4 per cent of the total crude oil refined in this country. It is processing currently more than 200,000 bbl. a day, or 73,000,000 bbl. a year. About 7 bbl. of crude oil are equivalent to a ton, so that Baytown handles about 30,000 tons a day and more than 10,000,000 tons a year.

At Baytown there are 4 government projects that have been designed and built by Humble and are operated by it for the government. The Baytown Ordnance Works is engaged in making toluene. The hydrogenation unit, recently completed at a cost of $4,250,000, contributes to the manufacture of 100-octane aviation gasoline. The Baytown butadiene plant provides raw material for buna-S rubber made at the adjacent copolymer plant. The Baytown butyl rubber plant produces finished rubber of the butyl type. Humble employs about 6000 men and women to operate these plants continuously every day in the year to supply the products needed for military and essential civilian uses.

▸ **Toluene.** Toluene is the final "T" in "TNT," which is an abbreviation of trinitrotoluene. The only important supplies of toluene until recent years were obtained by coking coal. The amounts that could be produced by this method would have been totally inadequate to meet the huge wartime demands.

Small amounts of natural toluene occur in petroleum naphthas and can be recovered by precise fractionation and purification. The quantities that could be manufactured by this method were relatively small. A process of chemical synthesis that was developed and perfected by Humble, Standard Oil Development Company, and other affiliated companies, has been the basis of the petroleum industry's great contribution to the supplies of toluene. Without this process, the tremendous bombing raids on Germany and in the Pacific could not have been carried out. Toluene produced from petroleum by chemical synthesis has accounted for two out of three of the bombs used by the United Nations.

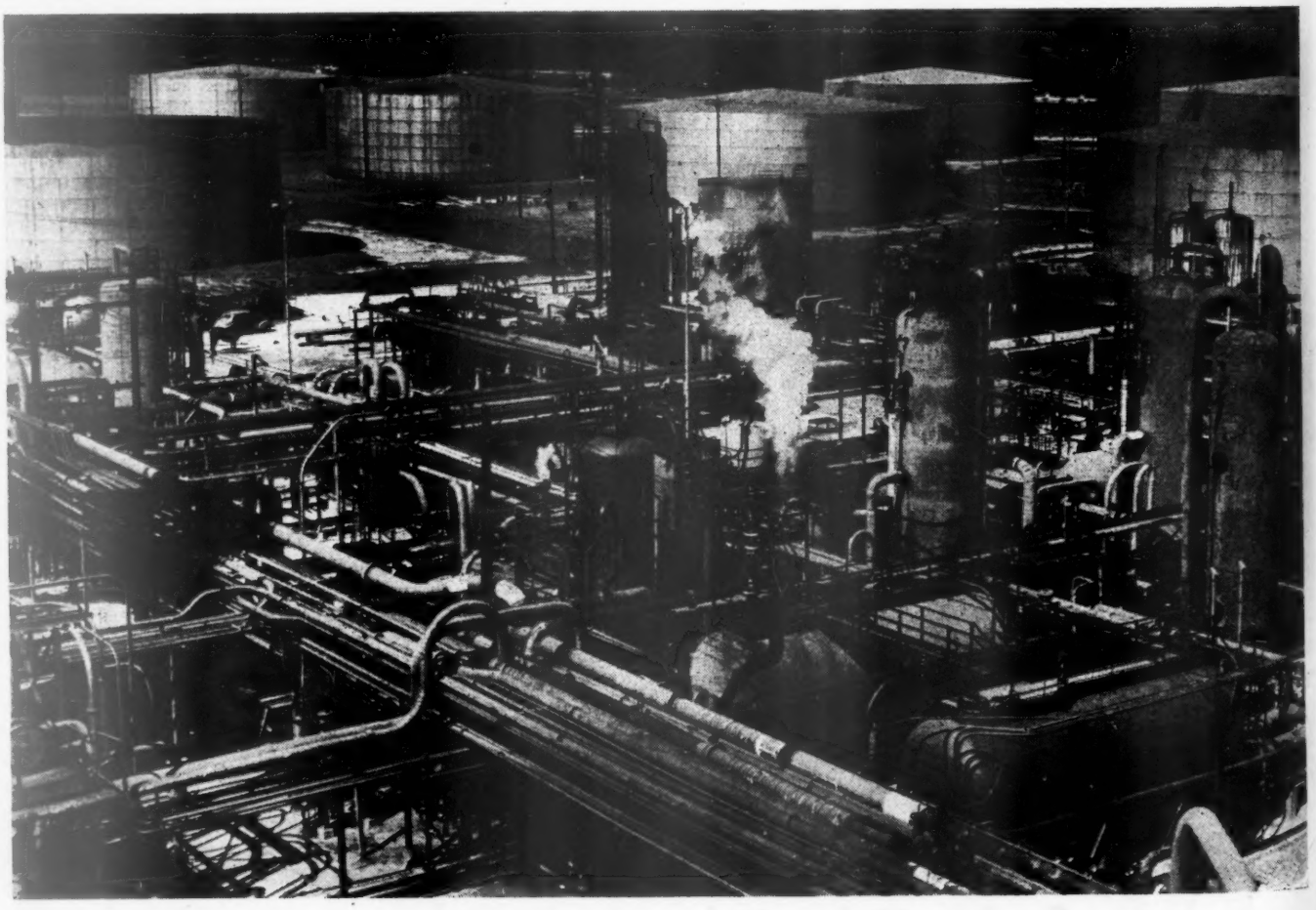
The Baytown Ordnance Works, first synthetic toluene plant in the world, has supplied more toluene since our entry into the war than was produced from all sources during World War I.

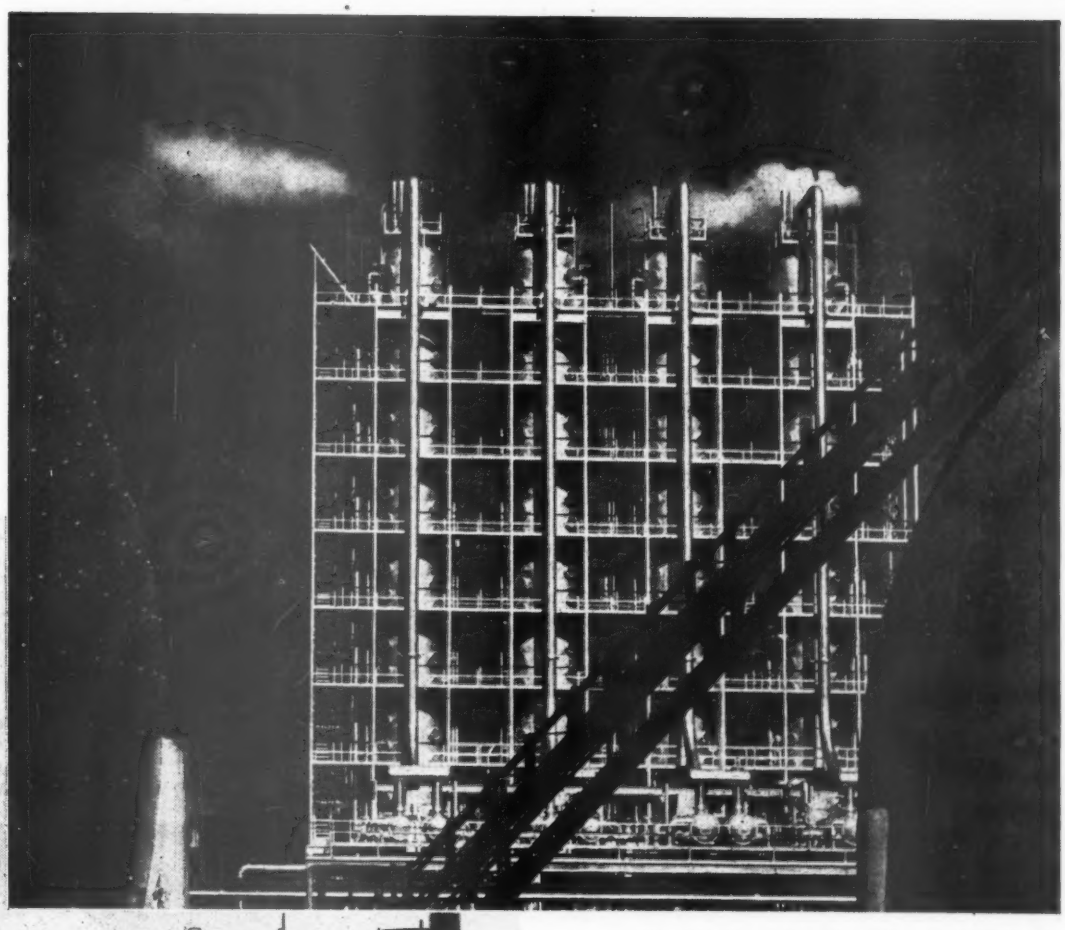
The contract for the Baytown Ordnance Works was signed in October, 1940, and the first shipment of toluene was made a year later, 47 days before this country actually became involved in the war.

The process begins with the use of large quantities of naphtha. The naphtha is first sent to a fractionating unit, which separates about half of the material that is best suited for toluene. This material then goes to a hydroformer. At the hydroformer, the feed stock is heated to over 1000°F. and passed through a catalyst. The removal of hydrogen converts certain components to toluene. The resulting products is then fractionated again, and finally sent to an extraction and purification unit that produces toluene of nitration grade specifications. The toluene must be a minimum of 99.0 pure, and production has been in the range up to 99.5 per cent pure. The final yield of toluene is about 10 per cent of the original volume of naphtha sent to the Baytown Ordnance Works.

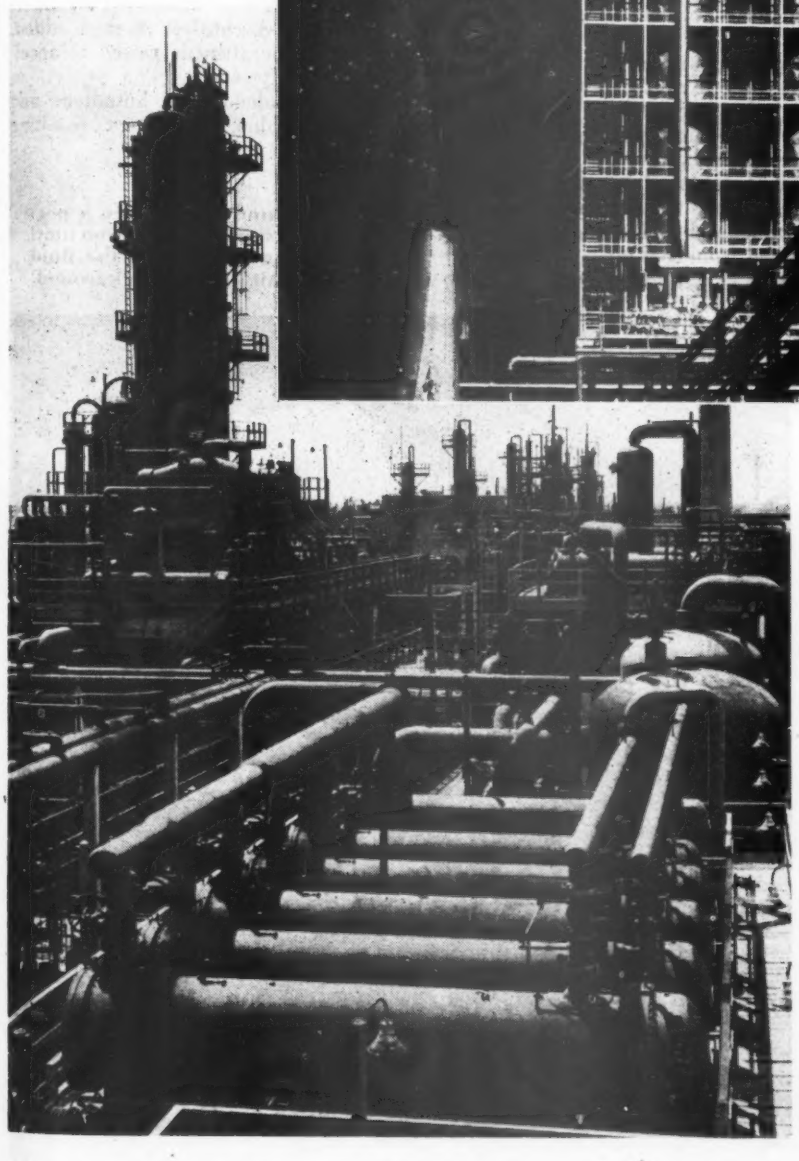
The Baytown Ordnance Works is producing toluene at the rate of two and one-third times the amount called for in the contract. Major General Campbell, Chief of Ordnance for the United States

A section of the alkylation plant. Constructed in 1938, this was the first commercial alkylation plant in the world and has helped to establish Humble's record in the manufacture of 100-octane aviation gasoline.





Below—A view of the 30,000-tons-a-year butyl rubber plant at Baytown. Finished rubber manufactured here is used for manufacture of innertubes, life rafts, gas masks, and other war materials.



Above—Superfractionating unit in background with storage tanks in foreground. Superfraction units act as a sort of octane sifter, separating the high and low octanes in the naphthas that come from various cracking processes in the refinery.

Army, has stated that the remarkable record of the Baytown Ordnance Works is important out of all proportion to the bare figures on production. It was in operation long before other plants could be constructed and served the nation during a most critical period. It was awarded the Army and Navy "E" in 1942 within a year after it started operation. It has recently been awarded the fourth star for continued excellence in performance.

▶ **100-octane aviation gasoline.** Pioneer research work done at Baytown, including the construction of the first alkylation plant in the world in 1938 has resulted in this plant producing more 100-octane aviation gasoline than any other refinery in the world.

Aviation gasoline of 100-octane rating has been an essential factor in enabling the United Nations to secure command of the air and to carry on the tremendous bombing raids to soften up Fortress Europe for the invasion. It takes several tons of aviation gasoline to deliver one ton of bombs on Europe, and additional aviation gasoline is required for the fighter planes.

Alkylation is a basic process in the 100-octane program. Alkylate is produced synthetically by combining isobutane with butylene and pentylene, which are light hydrocarbons derived by cracking petroleum. One of the limiting factors in making alkylate is isobutane, which differs from the normal butane used by many household heating systems in the arrangements of the molecules. In order to supplement Baytown's normal supplies of isobutane, some old refinery apparatus was converted into isomerization equipment, which converts normal butane to isobutane in the presence of a catalyst and dry hydrochloric acid. This provides enough isobutane for Baytown's 5 alkylation plants.

Superfractionation is another important process developed at Baytown to increase the output of aviation gasoline. This unit consists of 4 fractionating towers that separate 15,000 bbl. daily of ordinary naphtha into five different

streams, 3 of which have high octane ratings of 74, 80, and 91 and are excellent base stocks for 100-octane gasoline, whereas the other 2 have low octane ratings. Without superfractionation, it would be impossible to separate the high octane components. Superfractionation improves the quality of the base stock so that much less of the scarce blending agents is required to meet 100-octane specifications. This makes possible a large increase in total production of 20 per cent over what would otherwise be possible.

The completion of the first fluid catalytic cracking unit in December, 1942, and a similar unit in February, 1944, at Baytown has contributed greatly to the 100-octane and synthetic rubber programs. Catalytic cracking is a new improvement upon the older process of thermal cracking. The catalyst in these units is a finely powdered clay, which is mixed with vaporized feed stock. The mixture circulates through the unit in the same manner as a liquid while the catalyst promotes the cracking reaction. The fluid catalytic cracking units at Baytown charge a special gas oil selected to give the highest yield of war products, which include aviation gasoline base stock, butylene for synthetic rubber, pentylene and isobutane for alkylate, and other materials that go directly into 100-octane gasoline.

A hydrogenation plant financed by the government and constructed and operated under contract by Humble is one of the most recent units completed to aid in the manufacture of war products at Baytown. The process involves catalytic reaction of naphthas to rearrange the molecular structure by adding hydrogen, so that the resulting products are better suited for aviation gasoline.

Butadiene. The Baytown butadiene plant has a rated capacity of 30,000 tons per year. It is a government plant built at a cost of $19,400,000. It was constructed and is being operated under contract by Humble. It is part of the government's $700,000,000 synthetic rubber program inaugurated after Pearl Harbor. The Baytown plant was placed in operation in August, 1943, being one of the first large units completed by the petroleum industry. It has produced about 32,500 tons of butadiene to date, sufficient for nearly 45,000 tons of buna-S rubber. The plant has exceeded rated capacity by about 50 per cent when a sufficient supply of butylene is available.

The possible need for synthetic rubber in case this nation were cut off from supplies of natural rubber became apparent in 1940. On October 7, 1940, exactly 14 months before Pearl Harbor, H. C. Wiess, president of Humble Oil and Refining Company, submitted a specific proposal to the government outlining the basis on which Humble might participate in a program to supply butadiene for the manufacture of buna-S rubber. There was considerable delay in acceptance of the need for a synthetic rubber program, but the course of the war after Pearl Harbor quickly demonstrated the importance of creating a large synthetic rubber industry. It was late in 1942 that the program providing for a capacity of 870,000 tons of synthetic rubber per year was finally worked out.

Butadiene is the basic ingredient for synthetic rubber of the buna-S type, which represents 85 per cent of the government synthetic rubber program. Butadiene is mixed with styrene in the proportion of approximately 75 per cent and 25 per cent to make buna-S rubber. Styrene is manufactured by the chemical companies from ethylene gas produced from petroleum by cracking, and benzene derived from coal tar.

Butadiene is made at Baytown by catalytic dehydrogenation of butylene. Butylene is a volatile hdyrocarbon recovered as a product from catalytic cracking operations. It is handled under pressure and low temperature as a liquid, but would be a gas under normal atmospheric conditions. The dehydrogenation process removes two hydrogen atoms from the butylene and results in a product with 4 carbon and 6 hydrogen atoms, which is butadiene. The material is then cooled, purified, and stored under pressure in insulated spheres. The butadiene must have a minimum purity of 98.5 per cent. It is finally delivered by pipe line to the copolymer plant, where it is converted into buna-S rubber.

At the copolymer plant, butadiene is mixed with styrene in batch operations. The two ingredients are fed into a soapy water solution and emulsified by vigorous stirring. A catalyst is then added, and the temperature is raised to accelerate the polymerization, a process in which the molecules of butadiene and styrene combine. The latex resulting

In foreground can be seen a portion of the superfractionation unit, with storage tanks and the fluid catalytic unit No. 2 in background.

ON PAGE 88

The upper picture shows tank cars being loaded at Humble's Baytown refinery. This is a familiar sight about a petroleum refinery during the war emergency.

Below is a view of the new hydrogenation unit recently constructed to improve base stocks for 100-octane aviation gasoline. This unit was formerly an old Cross coil that was converted to hydrogenation as a war measure.

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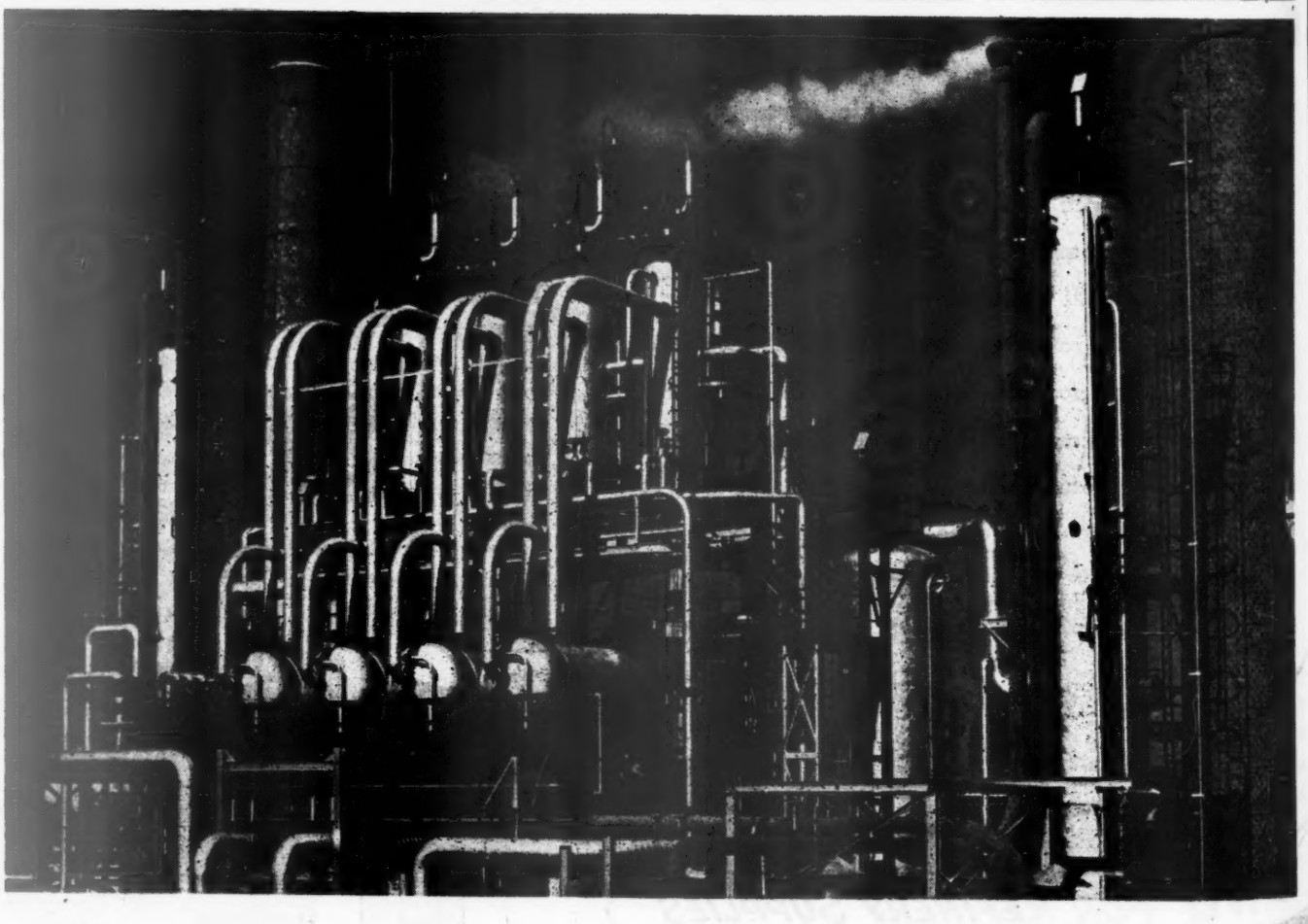

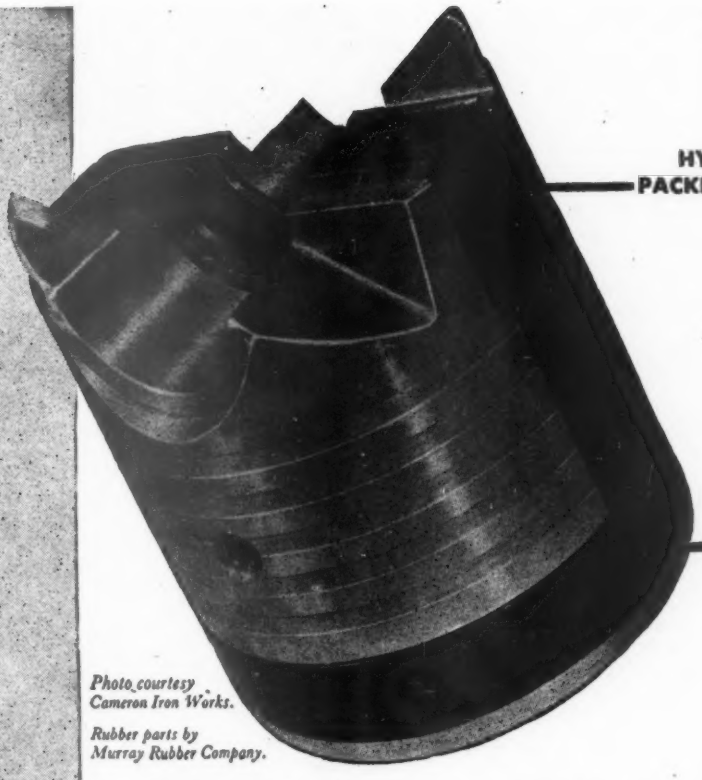

Photo courtesy Cameron Iron Works.

Rubber parts by Murray Rubber Company.

HYCAR PACKINGS PREVENT WASTEFUL OIL WELL BLOWOUTS

Resist oil and abrasion to give positive seal against high pressures

As nearly every oil man knows, many wells drilled below 10,000 feet in recent years have depended on Cameron Blowout Preventers to eliminate the chance of costly, dangerous blowouts like the one in the picture. But it may not be so well known that the self-feeding ram packing element in the Cameron preventer is made of Hycar synthetic rubber.

There's a reason behind the selection of Hycar for this severe service. Certain properties—in just the right combination—are essential: Oil and gas resistance, to prevent deterioration and weakening of the packing; abrasion resistance, to stand 6 or 8 hours rotation of the drill pipe while weighting material is being added to the drilling mud; permanent resilience, to provide a positive seal when the need suddenly arises as a high pressure zone is penetrated.

Hycar provides these properties—*and in just the right combination.* Other properties are listed in the box at the right. That list will tell you why Hycar has so many oil field applications—gate packers in mudline valves, casing head seals, gaskets of all kinds, drilling and suction hose, and many others.

Ask for parts made of Hycar. Test them yourself in your own tough applications. Learn for yourself that Hycar can help reduce operating costs—that it's wise to use Hycar when the going gets tough. *Hycar Chemical Company, Akron 8, Ohio.*

WHAT HYCAR DOES IN OIL FIELD APPLICATIONS

1. Resists oil and gas—even under high pressure.
2. Resists action of abrasive-laden fluid under high pressure and at high velocity.
3. Wears at slow rate even under worst conditions.
4. Makes a positive, leak-proof seal, even after a long period of service.
5. Provides high elasticity.
6. Gives high tensile strength.
7. Has minimum tendency to cold flow and compression set.

Hycar

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LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

Synthetic Rubber

Free—write for your copy of the new pocket-size Hycar Glossary of commonly used synthetic rubber terminology.

Finished butyl rubber comes off in 14-in. strips; it is then cut, packed, and weighed for shipment to Rubber Reserve.

from the operation is placed in another tank where sulphuric acid and a salt solution are introduced. The latex coagulates, and the rubber crumbs are filtered out, washed, dried, pressed into blocks, and packaged for shipment to the manufacturers of rubber goods.

Butyl rubber. Butyl rubber accounts for about 8 per cent of the United States government synthetic rubber program, as it provides for a capacity of 68,000 tons per year. Butyl differs from buna-S rubber both in manufacturing process and in physical properties. Buna-S rubber is particularly suited to the manufacture of tire casings, whereas butyl rubber is particularly useful for inner tubes and certain other purposes. The Baytown butyl rubber plant has a rated capacity of 30,000 tons per year. It was built by the government at a cost of over $25,000,000 and is operated under contract by Humble.

The raw material for the plant is a butane-butylene mixture supplied by the Baytown refinery. The first step is to extract isobutylene by a process using sulphuric acid. Isobutylene differs from normal butylene in the arrangement of the carbon and hydrogen atoms.

The isobutylene is mixed with 2 or 3 per cent isoprene, which is made by steam cracking of gas oil, and charged to a reactor. The isoprene used at the Baytown butyl rubber plant is purchased from another refinery. The reaction of isobutylene and isoprene results in a slurry, which consists of small particles of butyl rubber carried in water. The water is then removed, and the particles are sent through a drier and a mill that compresses them into finished butyl rubber.

There are a number of interesting features in the butyl rubber process. One of the outstanding is the extremely low temperature of minus 140°F. required for the reaction that takes place in a fraction of a second. Another is that butyl is the only rubber now made commercially by a continuous process. Other synthetic rubbers are made in small batches where the raw materials are charged to reactors and allowed to remain for a time, with the product being removed after the reaction is completed.

The continuous process in the manufacture of butyl extends to the final packaging of the product. The butyl rubber is first manufactured in sheets about ½ in. thick and is then compressed into packages that are placed in cardboard boxes for handling and shipment. Before the rubber is vulcanized, it is quite sticky and has a tendency to adhere to adjacent surfaces. At the Baytown plant, there are two separate conveyors to handle the butyl rubber.

The Baytown butyl rubber plant was placed in operation in September, 1944. The process involved is a new one that had to be rushed into plant-scale operation before there was time for adequate development through experimentation with pilot plant units. Consequently, numerous difficulties have been encountered in the initial operations, but many of these have already been overcome.

★ ★ ★

WHEN STARTING THAT NEW BOILER

W. F. Schaphorst

MANY an expensive new boiler has been ruined on the very first start because the protecting grease was not removed. It is not uncommon for makers to cover the boiler surface with a rust preventive so that it will reach the ultimate user in tip top condition. This protecting film should be carefully removed before the boiler is used, which is easily done by preparing a strong solution of soda ash and boiling it slowly in the boiler. Then drain it out. If any trace of oil remains, flush it out with hot water. Oil in a boiler is bad because it sometimes causes bagging, and bagging may lead to failure.

If the setting is also new be sure that it is thoroughly dried before the boiler is put to work. The best way in which to do the drying is to build a slow fire in the combustion chamber and keep that fire going until the setting is completely dry—all moisture driven. Thus if there is oil in the boiler as mentioned above, that process of heating the soda ash solution will at the same time help to dry out the setting, thereby "killing two birds with one stone."

Start a boiler too soon, with a damp setting, and costly cracks are likely to appear. Cracks in settings are costly because they permit inleakage of air, and inleakage in turn tends to reduce the temperature of the boiler. So, if necessary, keep the slow fire going for a week or more—until you are certain that all is well. Then go ahead and "fire up."

★ ★ ★

Maximum PERFORMANCE AT *minimum* EXPENSE

•VERNON-CORWIN DESANDERS and McNEELY VIBRATING MUD SCREENS are correctly designed and carefully built to save time, labor and money. Because of this, they assure the maximum in performance and the minimum in operating expense on the job. So if you want the BEST, investigate these VERNON products. VERNON has been making quality oil well specialties for years.

At Right: VERNON-CORWIN DESANDER. *Below:* McNEELY VIBRATING MUD SCREEN. This is available in three models—A-1 with 9 square feet of screening surface; G-7 with 16 square feet, and F-6 with 20 square feet.

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Unitized Drilling Mud Outfit consisting of a VERNON-CORWIN DESANDER, two Model G-7 McNEELY VIBRATING MUD SCREENS and a McNEELY MUD PUMP. Smaller view shows unit with Desander in position for transportation.

DUAL COMPLETION WELL PROGRAM AIDS RAPID DEVELOPMENT OF NEW HOPE FIELD

By C. C. PRYOR, *Associate Editor*

EXCLUSIVE RAPID development of oil pools through the drilling and completion stage is greatly aided by the establishment of drilling and completion methods that are suitable for that particular field. During the past several years, the shortage of materials, manpower, and the necessity for increased crude oil production has led many operators to investigate carefully dual completion of both oil and gas wells. The fact that dual completion is a successful and economical production method is attested to by the large number of such installations. Many of the problems associated with dual completions have been overcome by engineers convinced of the merits of the method of producing two individual zones from one hole.

One of the most ideal fields for dual completion of its wells is the New Hope field of Franklin County, Texas, about 12 miles south of Mount Vernon. General outline of the New Hope field is indicated by the map in Fig. 1 as running east and west. The producing zones in this field contain a low gas-oil ratio, no water, sufficient pressure for flowing production, and produce a crude oil with a relatively high specific gravity.

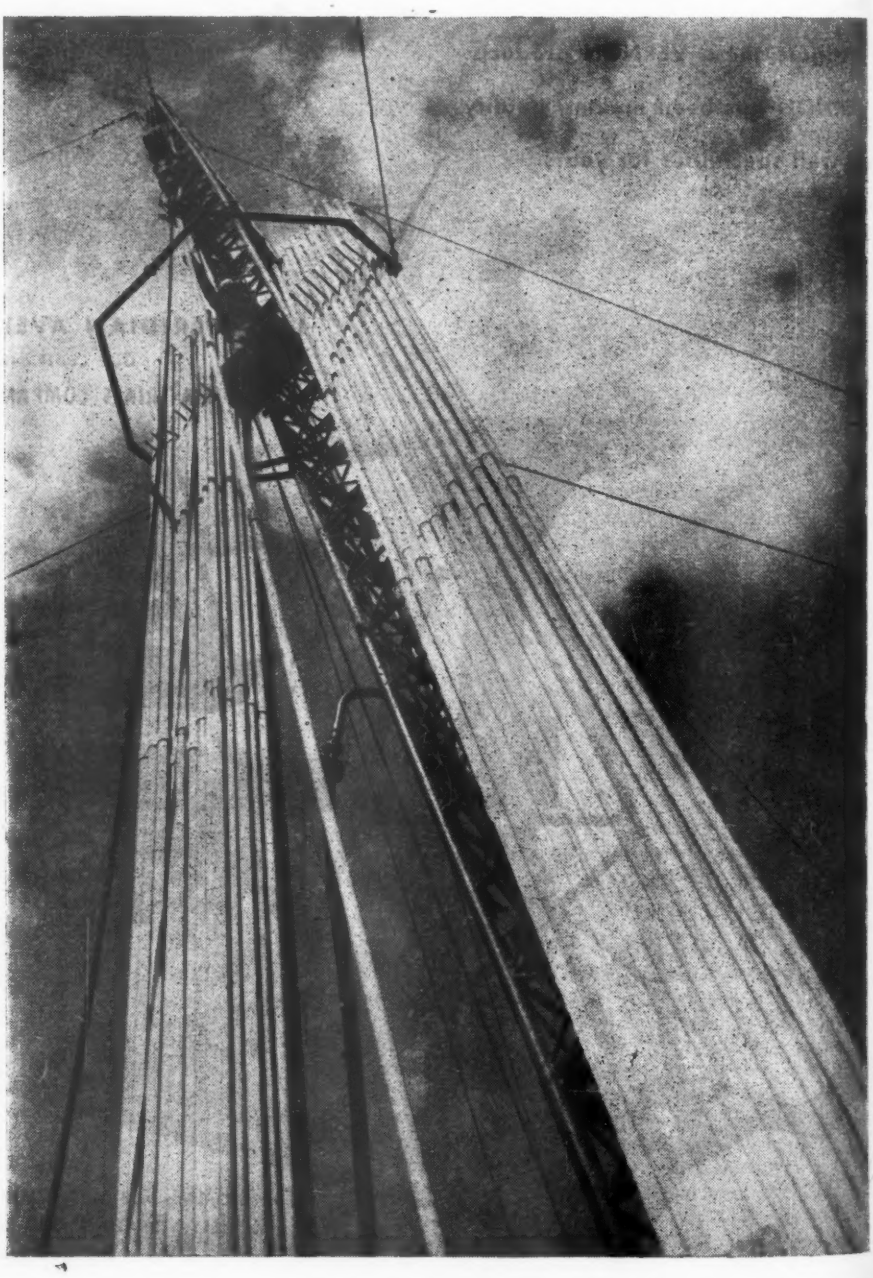
At the present time 26 wells have been drilled. All are dual completion wells except the first single completion in the Pittsburg sand. One well is being completed and 8 other wells are drilling. Construction of warehouses, field offices, houses for the operating personnel, laboratories, and shops has been completed. A system of all-weather roads into and throughout the field is nearing completion.

The New Hope field was discovered by seismograph exploration early in 1943. It had been the intention of the operators to single-complete the wells in the Pittsburg sand with the casing set on top of the zone.

▸ **Producing zones.** The Pittsburg sand was found in the discovery well from 7900 ft. to 8090 ft. The Bacon lime was drilled through and perforated from 7295 ft. to 7305 ft. As this zone was unexpected during drilling to the Pittsburg, less than 1 ft. was cored, however, it was perforated and tested after a log indicated possible production. The Bacon lime is immediately below the Massive Anhydrite in the lower Glenrose series of Lower Cretaceous age. The Pittsburg sand is equivalent to the Pettit lime and is regarded as the top of the Travis Peak. This sand is not productive throughout the entire section. Production is generally obtained from 7930 ft. to 7965 ft. with thin sands possibly productive in the section.

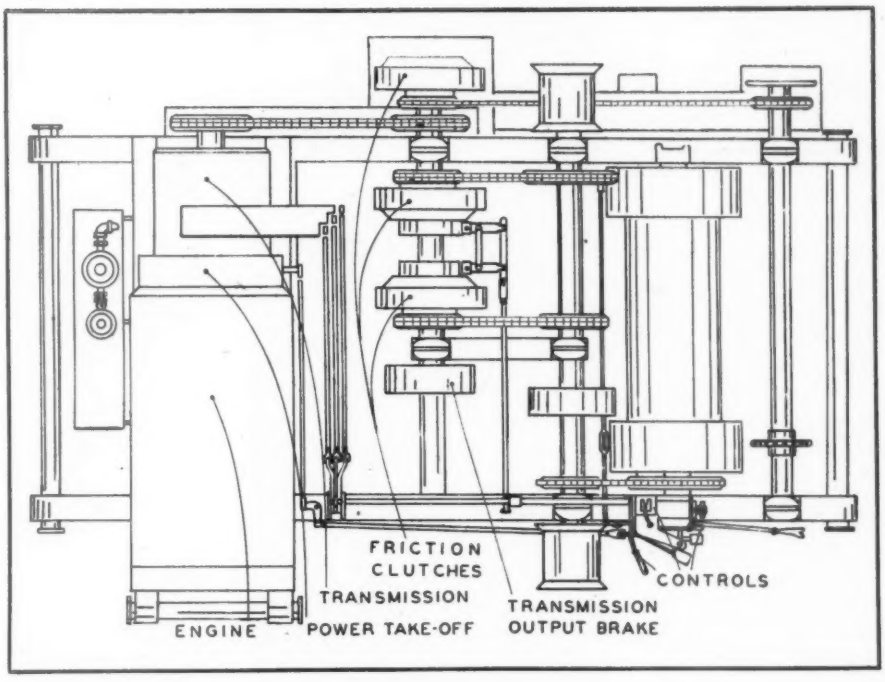
On the potential tests, the Pittsburg sand in the discovery well flowed 208 bbl. of 47.3 gravity oil through a 5/32-in. choke per 24 hr. The gas-oil ratio was 554 cu. ft. per bbl., casing pressure 940 lb., and tubing pressure 700 lb. The Bacon lime when tested flowed 348 bbl. of 41.5 gravity oil through a 5/32-in. choke per 24 hr. with a gas-oil ratio of 231 cu. ft. per bbl.; casing pressure was 840 lb., and tubing pressure 750 lb. Oil produced from the Pittsburg sand is a dark green colored oil and the oil from the Bacon lime is dark brown in color.

The Hill sand drilled through in the first well was not cored, however, when logged possible production was indicated



The 90-ft. derrick of the completion rig handles pipe in doubles and is designed to service 12,000-ft. deep wells with 2½-in. tubing. In the photo, the derrick man is waiting for the crew below to break a connection to rack another stand of pipe.

FIG. 2
Sketch of the layout of the drawworks of the completion rig showing the engine, power take-off, transmission, clutches, transmission output brake, and the driller's controls. The drum has a capacity of 7840 ft. of ⅞-in. drill line.



and the sand was cored in the second well from 7433 ft. to 7446 ft. Potential tests on this sand were made through the casing annulus and the well flowed 412 bbl. of 45.3 gravity oil through a 10/64-in. choke with a gas-oil ratio of 207 cu. ft. per bbl. and a pressure of 870 lb. The Pittsburg sand was completed for production through the tubing. Oil produced from the Hill sand is black.

Deepest production of the four-zone field is from the Elledge sand between 8156 ft. and 8190 ft. The first completion in this zone was made through perforations, the well flowing 205 bbl. of 52 gravity oil with a gas-oil ratio of 1667 cu. ft. per bbl. through a 10/64-in. choke. The tubing pressure was 1250 lb. and the oil a cream color.

▸ **Formations.** The deepest well in the field was drilled to 8706 ft. without finding additional productive zones below the Elledge sand. Wells drilled in the New Hope field, as shown in the log of Fig. 3, penetrate the Woodbine sand, which is not productive, at about 4580 ft.; the Georgetown limestone, top of the lower Cretaceous (Comanche), from approximately 4600 ft. to 5600 ft.; the Goodland lime from 5600 ft. to 5665 ft.; and the Paluxy from 5665 ft. to about 6000 ft. where the top of the upper Glenrose series begins. A 150-ft. section of Massive Anhydrite underlies the upper Glenrose series from 7100 ft. to 7250 ft. and is followed by the top of the lower Glenrose series. Approximately 40 ft. of the top of the lower Glenrose series is productive and is the Bacon lime. The Hill sand is about 100 ft. below the Bacon lime and ranges from 25 to 30 ft. in thickness to a depth of about 7400 ft. Following the Hill sand is the Gloyd lime, from 7510 ft. to 7630 ft., which is not productive. The Young lime, not productive, is below the Gloyd lime from 7670 ft. to 7730 ft. The Pittsburg sand is equivalent to the Pettit lime and is usually about 175 ft. below the Young lime. This sand is productive in the Pittsburg field about 7 miles east of the New Hope field. Production, however, is obtained by pumping in all except a few wells. The Elledge sand is several hundred feet below the Pittsburg sand and like the Pittsburg is produced through the tubing, whereas the Bacon lime and Hill sand are produced through the annular space. Whenever possible the dual wells are completed in the Hill and Pittsburg sands.

▸ **Drilling and completion.** The shortage of drilling rigs, manpower, and materials, and the necessity of rapid development of the field, have resulted in an extremely practical drilling and completion program. Large rigs capable of drilling with 4½-in. drill pipe to a depth of about 8300 ft. are used to drill the well to bottom. These rigs are moved to a new location, however, before the well is completed as a producer. A portable rig capable of servicing wells of this depth is moved in to drill out the cement plug and accomplish final completion of the well as a producer. At the present time the average drilling and comple-

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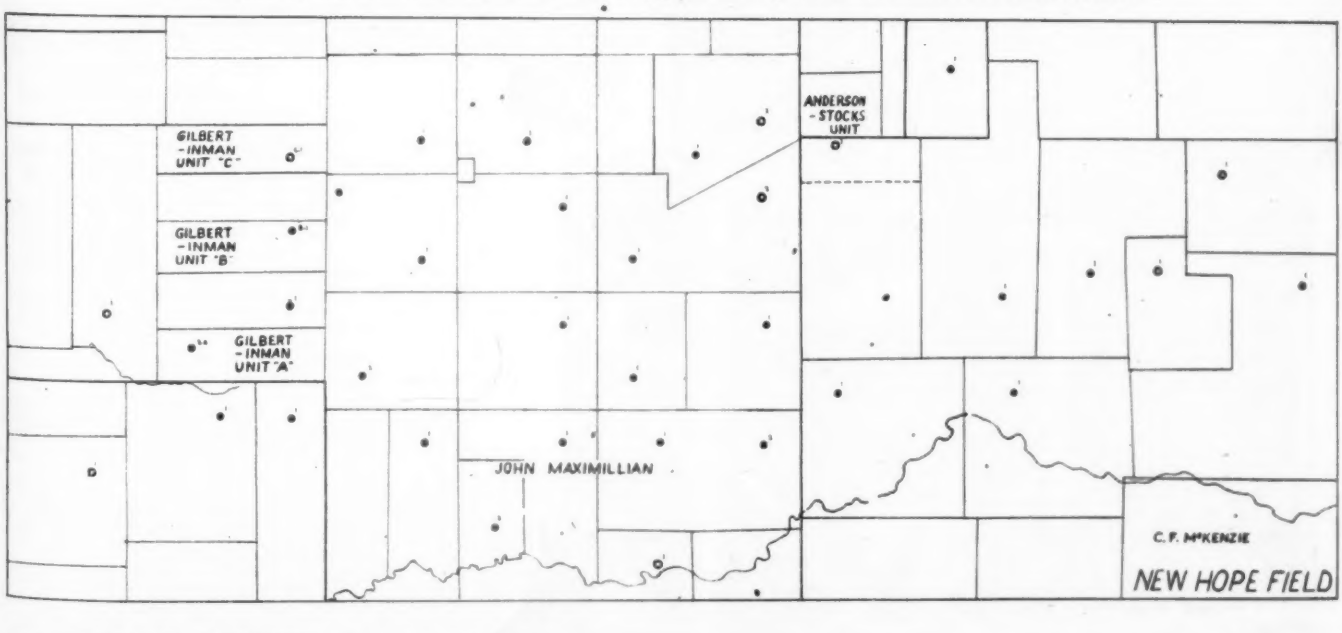
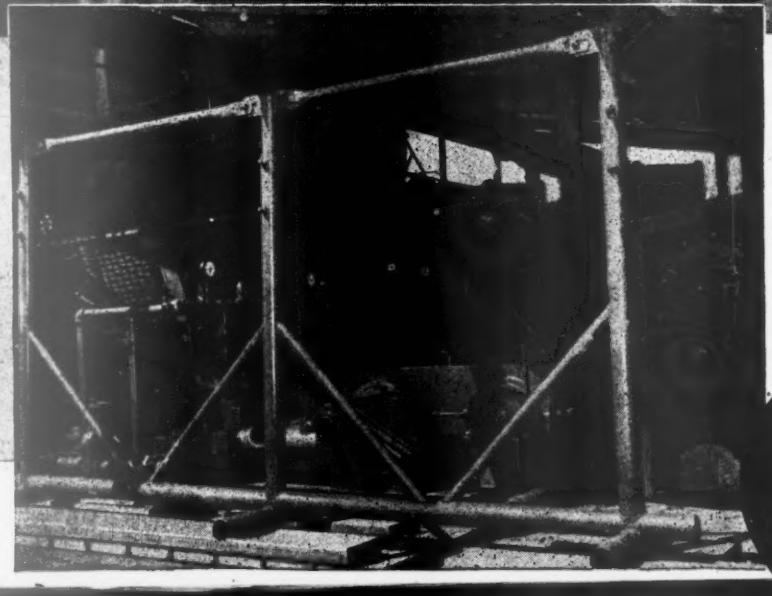
FIG. 1
East-West map of the New Hope field in which 26 wells have been completed, one is being completed, and 8 are drilling. The field is approximately 12 miles south of Mount Vernon.



Right: View of Starting Engine side of Climax VU-420 H.P. 12 Cylinder Engine and Stair-Step Drive from Compounding Transmission to Selective Transmission to Drawworks, illustrating further, individualized Selective Transmission and Sub-Structure package with oil country skids. (Stair-Step Sub-Structure removable from main skid, if desired.)

Now THE EMSCO J-1250 POWER DRILLING RIG



Left center: Illustration of Master Clutch and Selective Transmission Drive of No. 1 Engine Shaft of Compounding Transmission, Water Cooled Exhaust on Climax VU-420 H.P. Power Units, Gardner-Denver ADR Compressor and V-Belt Drive.

Left: View of compounding Transmission showing 300 H.P. outside Slush Pump Drive, Wash Down Pump Assembly with suction and discharge manifolding and Engine exhaust pipe supports.

THE CONTINENTAL SUPPLY COMPANY

General Offices: DALLAS, TEXAS

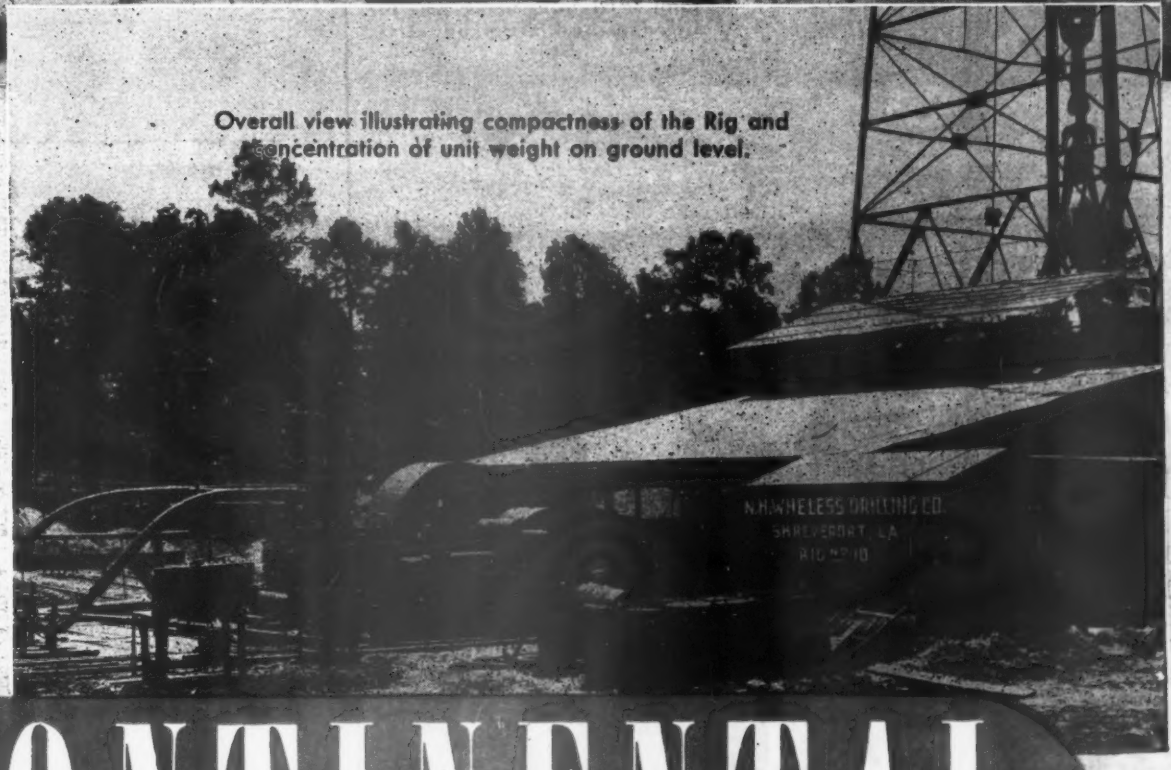
EXPORT DIVISION

30 Rockefeller Plaza New York City, N. Y.

Representatives

MEXICO ARGENTINA ENGLAND TRINIDAD BRAZ

Front view of Emsco J-1250 Drawworks illustrating simplicity of Control. Telescopic Oil-tight Rotary Guard and Hydromatic Brake mounting.



Overall view illustrating compactness of the Rig and concentration of unit weight on ground level.

CONTINENTAL

SERVING THE OIL AND GAS INDUSTRIES

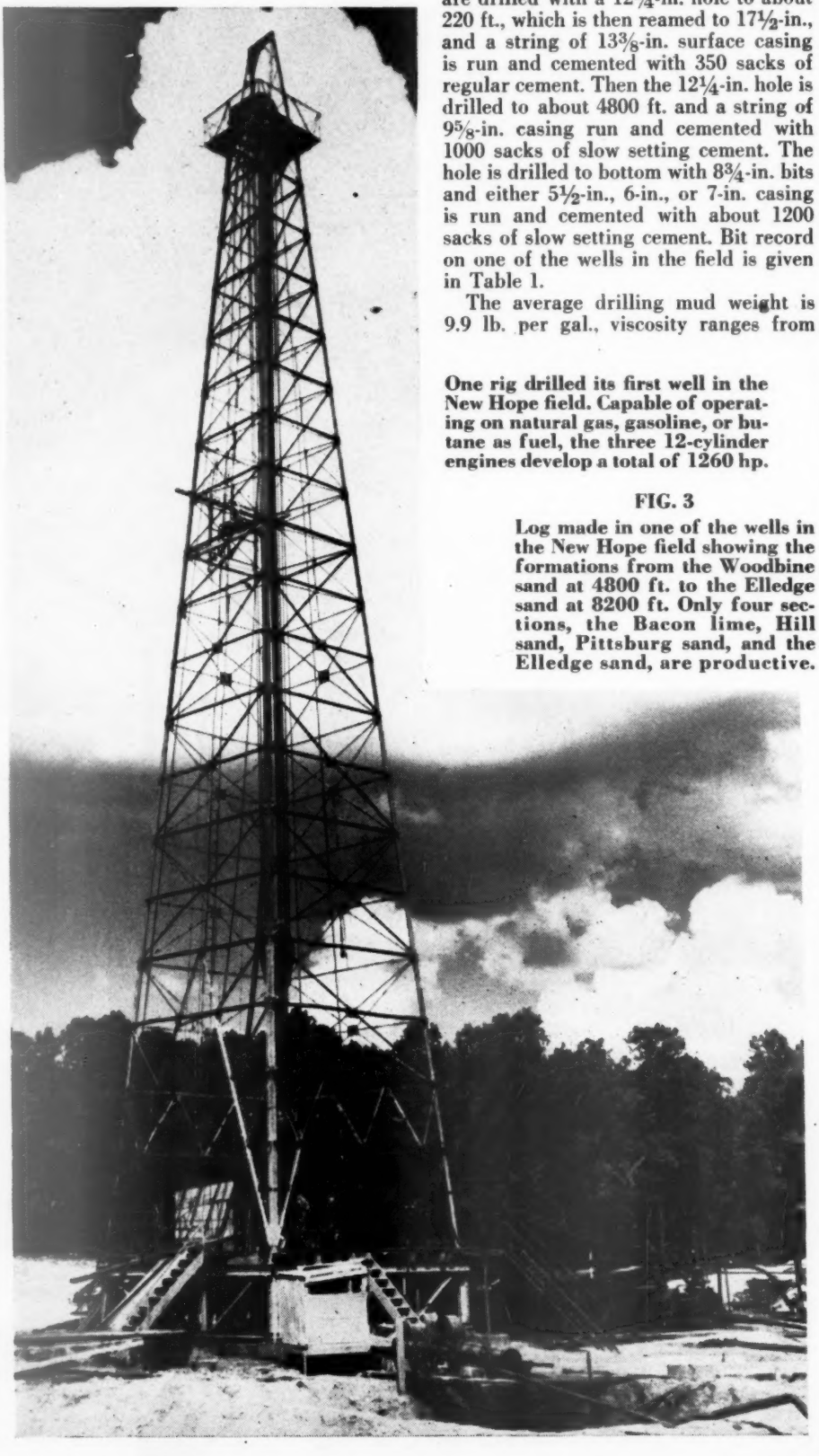
(Continued from Page 95)

TABLE 1

No. bits	Type bit	Size, in.	Depth, ft.	Avg. per bit, ft.
1	reamer	12¼-17½	217	217
4	rock	12¼	4343	1031.5
3	rock	12	4800	152.3
31	rock	8¾	7965	102.1

tion time per well is about 78 days. This time is a reduction of about one third the time required on wells drilled earlier in the development of the field. The wells are drilled with a 12¼-in. hole to about 220 ft., which is then reamed to 17½-in., and a string of 13⅜-in. surface casing is run and cemented with 350 sacks of regular cement. Then the 12¼-in. hole is drilled to about 4800 ft. and a string of 9⅝-in. casing run and cemented with 1000 sacks of slow setting cement. The hole is drilled to bottom with 8¾-in. bits and either 5½-in., 6-in., or 7-in. casing is run and cemented with about 1200 sacks of slow setting cement. Bit record on one of the wells in the field is given in Table 1.

The average drilling mud weight is 9.9 lb. per gal., viscosity ranges from



One rig drilled its first well in the New Hope field. Capable of operating on natural gas, gasoline, or butane as fuel, the three 12-cylinder engines develop a total of 1260 hp.

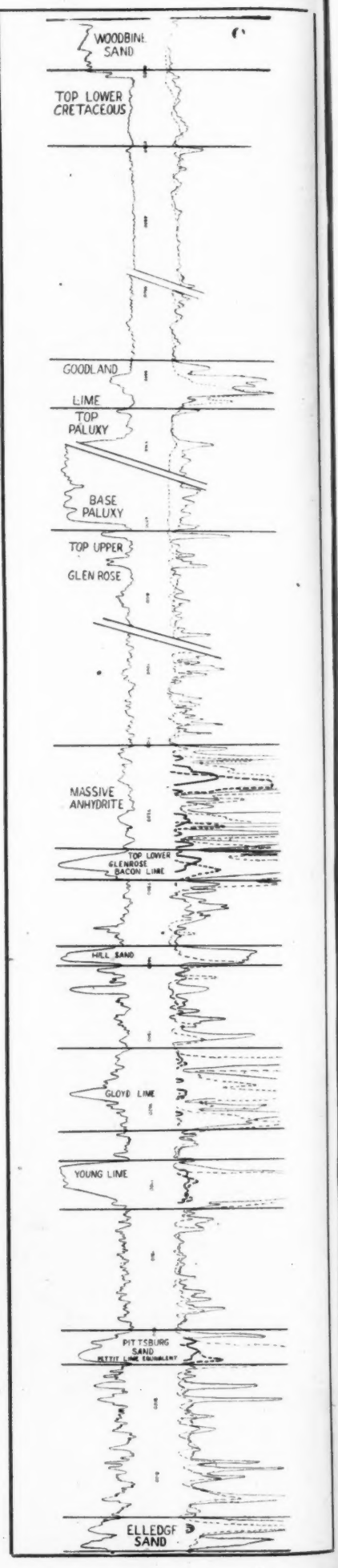
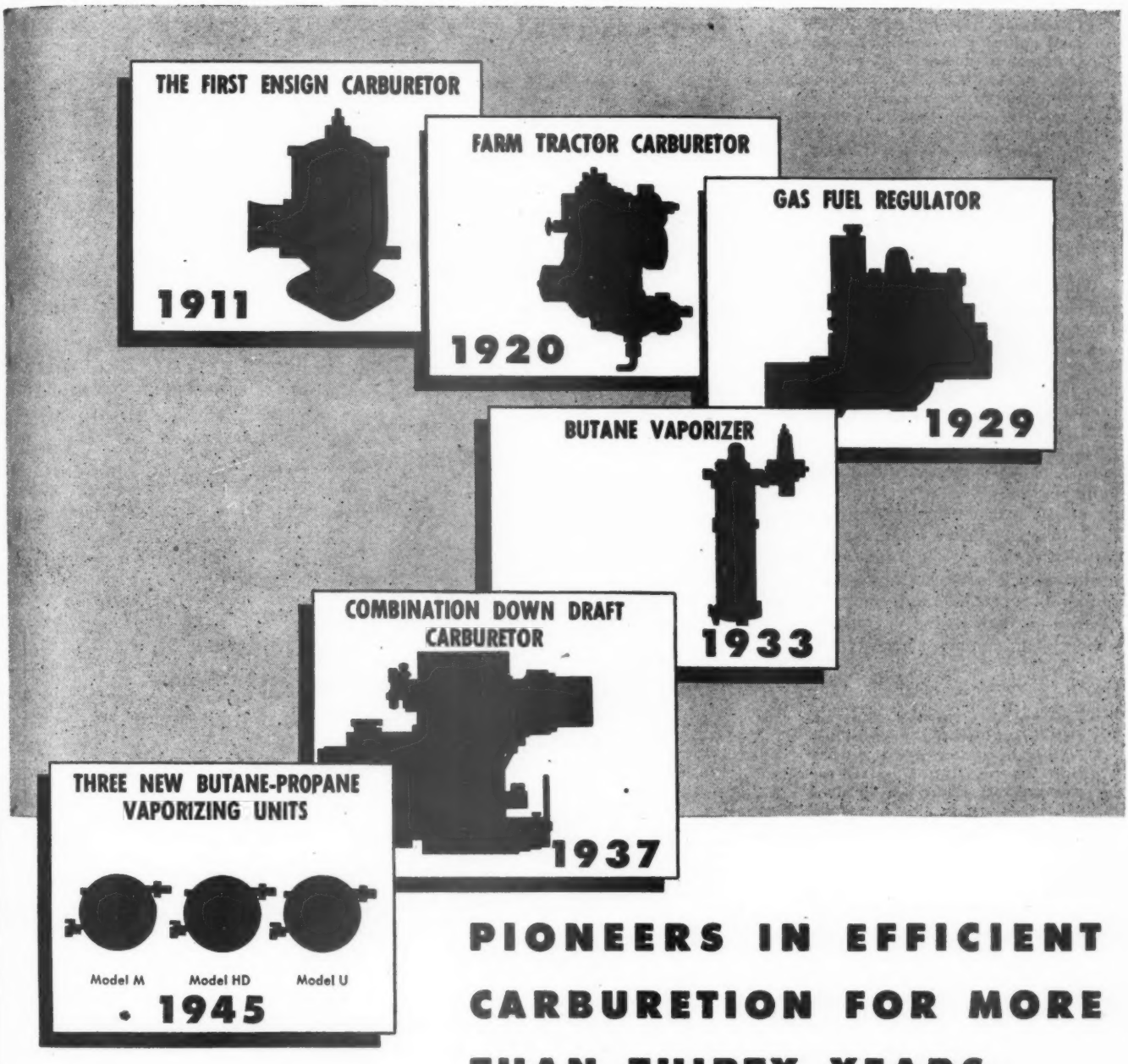


FIG. 3

Log made in one of the wells in the New Hope field showing the formations from the Woodbine sand at 4800 ft. to the Elledge sand at 8200 ft. Only four sections, the Bacon lime, Hill sand, Pittsburg sand, and the Elledge sand, are productive.



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HUNTINGTON PARK, CALIF.

Christmas tree on one of the dual completion wells. The tree consists of 5 sections and is equipped with a 30-ft. polished rod that permits the packer to be reset, the well killed, and other operations without plugging the tubing or removing the tree.

35 to 47 seconds (500 cc. in and out), filter cake 4/32 in. and water loss 14 or less.

When the well has been drilled, cased, and cemented, the large rig is moved off. The completion rig is then moved on the well and the christmas tree and tubing removed. The cement plug is drilled out to a point about 50 ft. below the lower producing zone, Pittsburg or Elledge sand, and a 3-ft. section of the sand is perforated and tested. Then both the upper and lower zones are perforated, a milling cutter run to remove any obstructions in the casing, and the packer run on the string of 2-in. tubing and set between the zones. The sands are then washed-in for production. The packer employed is the hookwall control head type with a slotted valve opening, which when closed confines the lower sand to

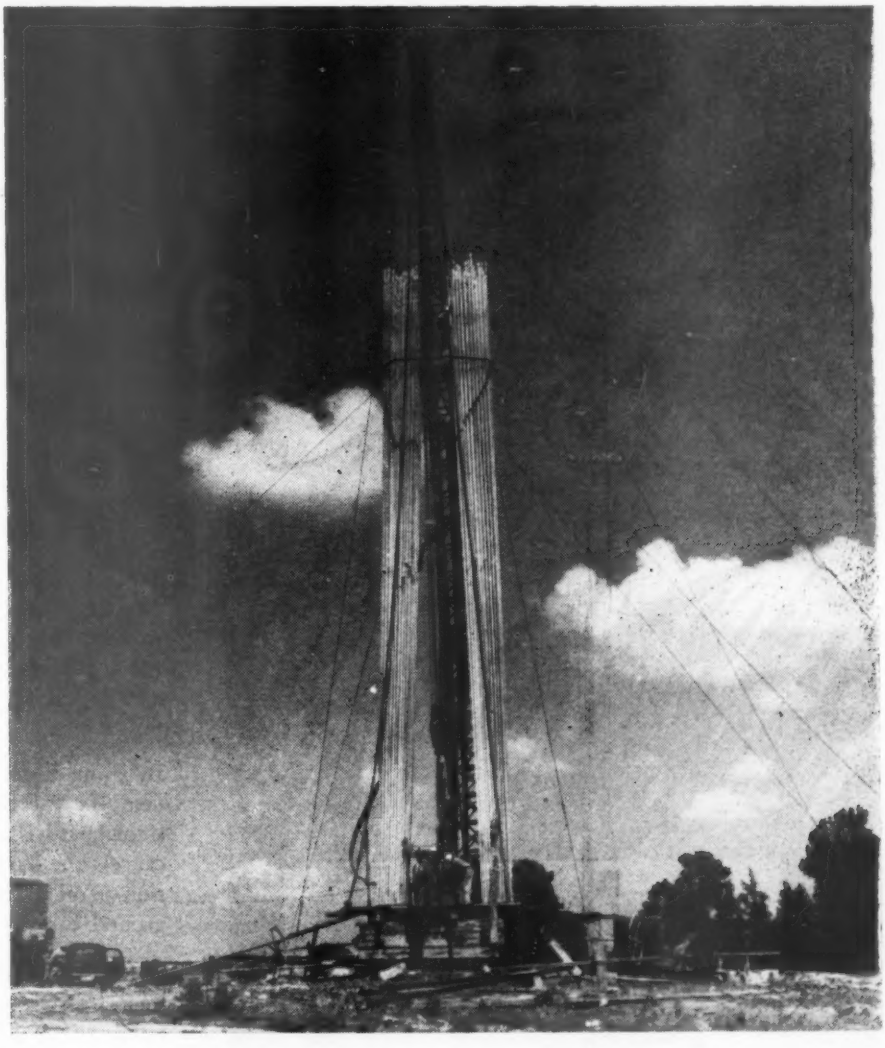
Closeup view of the floor of the completion rig showing compactness and ease of operation. The drillstem is laid on the ground when not in use.

the tubing. Each zone is produced separately. An oil and gas separator and two 1000-bbl. tanks are supplied for each zone in the dual tank batteries. The wellhead manifolds were designed for dual completion wells. Constructed in five sections the christmas tree is primarily designed for use in wells where the tubing will remain connected to the packer as is the case where a hookwall type packer is used. The flowing connection for each zone is supplied with a Unibolt tee containing a flow bean. Design of the christmas tree includes a 30-ft. polished rod on the upper end of the tubing string with a tubing hanger to seal the annular space in the third section or tubinghead of the tree. The polished rod permits complete installation of the christmas tree before setting the packer, simplifies washing-in, killing the well, or resetting the packer without plugging the tubing or removing the tree.

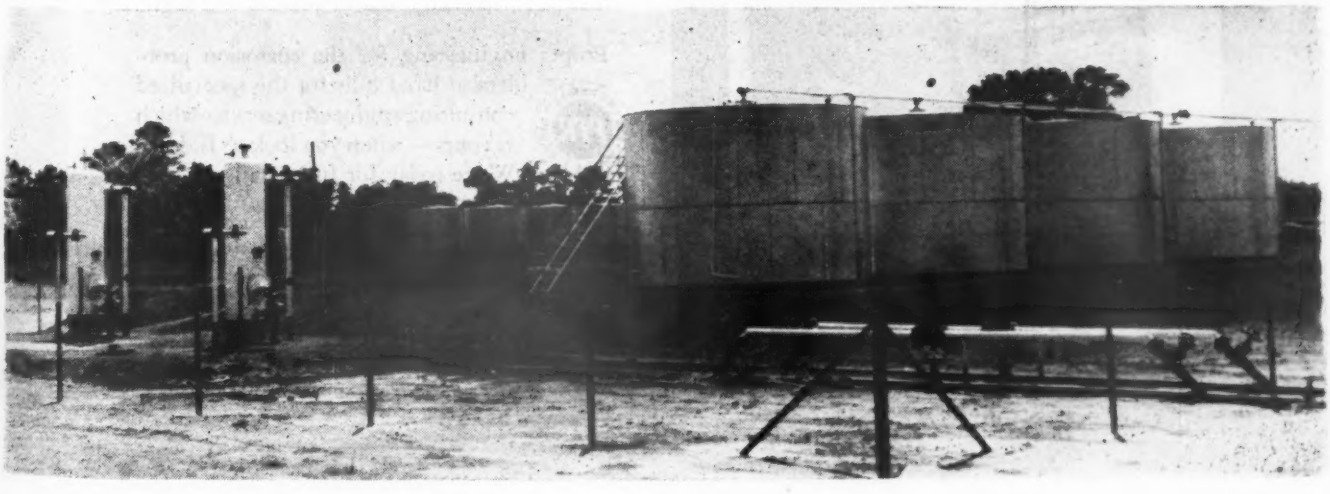
Completion rig. The completion rig employed in the New Hope field consists of the portable derrick, drawworks and engine, rotary table and drill stem, and the mud pump and engine. Four hours are required for erection of the cantilever three-section tubular type derrick and for rigging-up. The height of the derrick is 90 ft. permittting the operator to stack pipe in the derrick in doubles. The dead load capacity of the derrick is 150,000 lb. using $\frac{7}{8}$-in. wire line to rig the six-line blocks. The record round trip in the field, made with 8200 ft. of 2-in. tubing, was 5 hr. and 25 min. The working load of the derrick is 85,000 lb. The derrick and drawworks are of a type used for completion and servicing of wells to a depth of 12,000 ft. Drilling mud circulation is supplied by a 6-in. by 16-in. pump driven by a 180-hp. gas, gasoline, or butane engine.

The drawworks (Fig. 2) employed on the completion rig is a fast, lightweight, compact unit equipped with skids that permit easy loading for transportation by truck. Power for the drawworks is supplied by a 132-hp. gas, gasoline, or butane engine operating at 1600 r.p.m. The drum barrel of the drawworks is of laminated steel construction of two $\frac{1}{2}$-in. plates, cold rolled and electrically welded. It is of the free-rolling, full release type, and revolves on a stationary shaft on self-aligning bearings. The diameter of the drum is 16 in. and length 50 in.; it has a capacity of 7840 ft. of $\frac{7}{8}$-in. drilling line. The drum clutch is a fan-shaped, eight-jaw type, designed to prevent disengaging under load and for equal jaw contact. Brakes are full-wrap, self-energizing with a single adjustment. Either brake will operate independently of the other to hold a load as an important safety feature for a completion or portable rig. The drawworks transmission is of the heavy-duty type that has high torque capacity.

★ ★ ★



Four hours are required for erection and rigging-up of the completion rig. Record round trip with the rig handling 8200 ft. of 2-in. tubing was 5 hr. and 25 min. in doubles.



Dual completion tank battery provides for each sand to be produced and handled separately. Production from each zone passes through a separator, then to two 1000-bbl. tanks. Gas is metered through the meter runs in the right foreground of the picture.

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"Leap-Frog" Corrosion damages underground pipes and cables.

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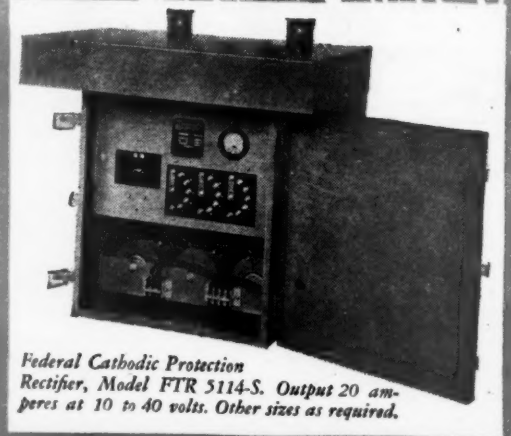

Federal Cathodic Protection Rectifier, Model FTR 5114-S. Output 20 amperes at 10 to 40 volts. Other sizes as required.

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CHOICE OF ROUTE IMPORTANT TO PIPE LINE CONSTRUCTION

By **FRANK H. LOVE,** *Managing Editor*

EXCLUSIVE DUE to the high altitude and roughness of terrain, selection of right-of-way played an unusually important role in the construction of Stanolind Pipe Line Company's 12-in. line from the Elk Basin field of Montana and Wyoming, to Casper. To construct this 232-mile line for the purpose of providing an outlet for Elk Basin crude, as well as oil from other fields along the route, it was necessary to lay pipe at elevations varying from 4250 ft. to 6328 ft., and elevations would have been even greater but for the fact that detailed consideration was given to selecting the route of the line, and all problems relative to construction and operation were anticipated prior to the actual start of work.

As a preliminary to laying the line, the right-of-way was determined by aerial mapping. What was considered to be the most satisfactory route was first flown over. Afterward the probable route was driven over, or as close to as terrain would permit, then aerial photographs were taken. At the altitude from which they were made the photographs included a strip 2½ to 3 miles wide, and after a close study of these pictures the most advantageous route was located within this area.

For the first 15 miles after leaving the Elk Basin field, the line traverses plains country, crosses bluffs, and enters the Shoshone River Valley. The Shoshone River itself is crossed about 10 miles northeast of Cody. From bank to bank this river is only 850 ft. wide. The banks, however, are 75 to 100 ft. high and the main channel of the river about 200 ft. wide and only 3 to 4 ft. deep, but exceedingly swift. Before the river crossing could be made it was necessary to reduce the grade of these high banks. Although the stream was shallow, the current was too swift for air drills to be used to make a trench for the pipe, consequently blasting was necessary. To place the charges dynamite was bundled in gunny sacks and weighted with rocks. Several blastings were required to remove enough rock to bury the pipe to a depth of 3 ft. below the bed of the river, and after each blasting a clamshell was used to remove the loose rock. A single line was laid but in the river proper extra heavy pipe was used, weighing 65.41 lb. per ft. On bank the pipe was welded into three sections at a time and, after being weighted with 1200-lb. river clamps, was pulled into place by tractors equipped with winches. That part of the pipe under water was not coated; however, the approaches were.

Stanolind's line from Elk Basin field to Casper, Wyoming, is laid through rough country and at high altitudes.

From the Shoshone River the line passes through an irrigation district for a distance of perhaps 10 miles, then intersects Highway 20 southeast of Cody. From there it enters mountainous country, and passes through the west edge of the Oregon Basin pool. The terrain was again rocky through this mountainous area. To make trench, ditching machines could be used to some extent but it was necessary also to blast, employ trench hoes, and even some hand work was required. Some of the mountains were so steep that tractors were used to tow

Coating and wrapping the 12-in. pipe with a combination travel-type machine.

ditching machines, trench hoes, and other construction equipment. The highest elevation of the line between Shoshone and Greybull rivers is 5950 ft.

Following along Highway 20 the line crosses the Greybull River north of the town of Meeteetse. The Greybull is a small mountain stream but has a swift current. The channel is about 5 ft. deep and 50 ft. wide. No construction problems were encountered because the location selected was at a point where the banks were reasonably low. The banks were graded for a short distance on each side and some blasting was done to make the trench. River clamps and extra heavy pipe were used the same as on the Shoshone River crossing.

Between the Greybull and Big Horn rivers a maximum elevation of 6225 ft. is reached. At Little Buffalo junction, between the two rivers, a 6-in. line was laid west for a distance of about 5 miles to gather oil from the Little Buffalo pool. From this junction to the Big Horn River the line is on a gradual slope; however, for 10 miles before the line reaches Grass Creek the country is rough. After it leaves Grass Creek the route follows the valleys of Grass Creek and Cottonwood Creek, which constitute fairly good pipe line right-of-way.

The Big Horn River has a sandy bottom, therefore it was possible to excavate the ditch with a trench hoe, no blasting being necessary. The river proper is 300 ft. wide. The 65.41-lb. pipe was welded on shore and pulled into place by tractors after 1200-lb. clamps had been installed.

After crossing the Big Horn River the line follows Kirby Creek for about 13 miles and works its way over the Owl Creek Mountains, which have an elevation of 6300 ft. Rock was encountered in many places, but was not solid throughout. This same type right-of-way exists until the line crosses Bridger Creek and Bad Water Creek, both small streams. The line then traverses a pass between Red Water Creek and Jackpot Creek at maximum elevation of 6250 ft. For 40 miles through this area the land is badly eroded. To lay the line satisfactorily it was necessary to fill in the washes to some extent by pushing off the tops with bulldozers.

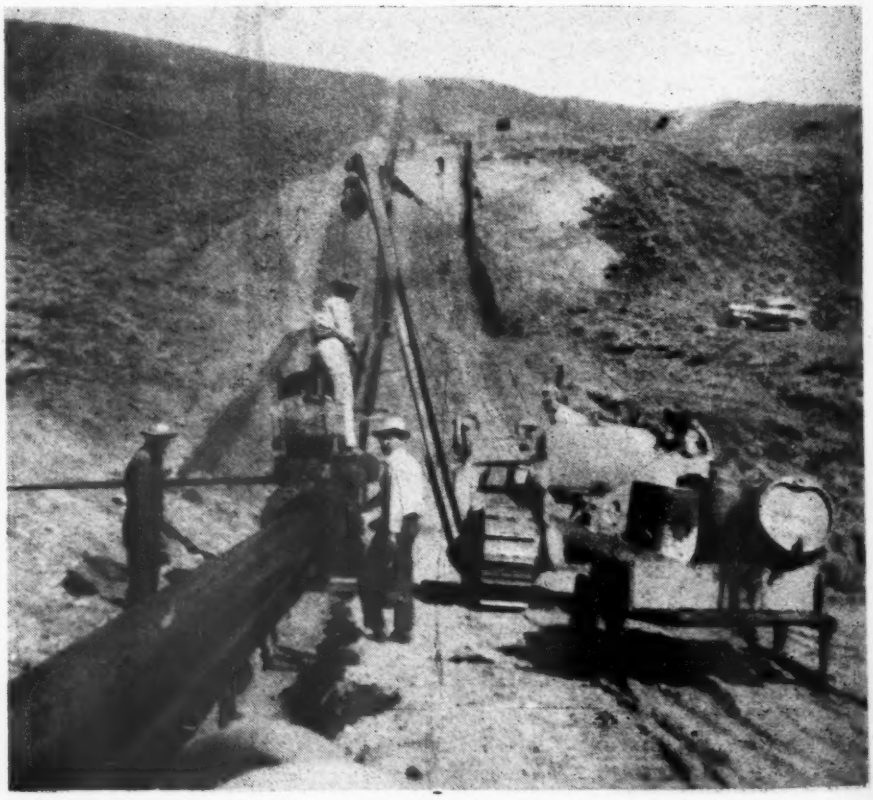
After passing the town of Arminto the line emerges onto plateau country at a maximum elevation of 6328 ft., the highest point on the line, and from there into Casper the right-of-way affords what is considered "easy pipelining." Before reaching Casper, however, Powder River is crossed immediately west of the town of Powder River. As would be surmised, this river is a virtually dry, sandy stream, containing little water except after a rain, and at the time the crossing was made there was very little water.

West of Casper the line crosses several irrigation ditches and the pipe had to be laid deep enough so that it would not interfere with irrigation activities. The larger ditches were spanned.

The line terminates at the tank farm of the Standard Oil Company Crude Oil Purchasing Department, northwest of Casper.

Line pipe. Four weights of seamless pipe were used in constructing the line, being utilized where most advantageous. The heavy pipe was used where pressures are greatest or where conditions of nature made it expedient, the lighter weight pipe being utilized in areas of low pressure. Mileages laid of the various weight pipe were as follows: 65.41-lb. pipe, 3000 ft.; 49.56-lb. pipe, 84 miles; 41.51-lb. pipe, 50 miles, and 33.38-lb. pipe, 97 miles. As has been stated, the weight of river pipe was 65.41 lb. per ft.

Welding. Line pipe was beveled to 37.5 deg. and all joints were welded by the electric method. Position or stovepipe welding was employed entirely due to its better adaptation to the terrain



Upper—**Welding pipe in the line through a mountainous stretch of country.**

Lower—**Cleaning and priming operations prior to coating. Except for pipe under water at river crossings and about 1900 ft. where terrain was extremely rocky the entire line was coated and wrapped.**

On the heavy pipe 4 and 5 beads were specified; on the light weight pipe 3 beads, sometimes 4, were run.

Stanolind was strict in its requirements for welders. Before a welder was hired by a contractor it was necessary for him to undergo a rigid test. The procedure called for an initial weld to be made, which was observed by a company inspector. Four coupons were taken from the completed weld and tested for tensile strength. If more than one coupon failed the welder was disqualified. Four additional welds were cut for nick break testing to examine the grain structure of the weld metal. Coupons were cut at 90 deg. intervals around the circumference of the pipe.

After a welder had passed these tests and was placed on the job, coupons were cut from the line at random and tested in the same manner to determine the workmanship of the welders as the work progressed. When a weld selected from the line in this manner failed to meet specifications, the welder was no longer permitted the classification of a welder but was given other work on the line.

Coating and wrapping. Except for the pipe under water at river crossings and 1900 ft. where very rocky, the entire line was coated and wrapped. The customary combination coating and wrapping machine was used and coating material was applied to a thickness of 5/32 in., followed by a wrapper of asbestos felt. In some of the more corrosive soils two coatings were applied and double coatings were also given pipe used at road and creek crossings. In the case of the latter, one coating was by machine and one by hand.

Valves. Block valves were installed for drainage control at principal river crossings and on slopes of mountain passes.

Pumping stations. Pumping installations at Elk Basin, the initial station, and at Kirby station, situated immediately west of where the line crosses the Big Horn River, are identical. At each, one 400-hp. 600-r.p.m. synchronous motor drives a vertical quintuplex pump that has an 8-in. stroke and operates at 175 r.p.m. Provision is made for the installation of a second unit. At Elk Basin station three 48,000-bbl. tanks have been erected and at Kirby station one 46,000-bbl. tank.

The Oregon station, about 18 miles south of Cody, is a temporary one, which will serve at least through this winter. Later a permanent high pressure station may be constructed. At present the pumping equipment consists of a 160-hp. gasoline unit. Two 10,000-bbl. tanks have been erected. Oregon Station is to handle Oregon Basin oil into the line.

On the gathering system in the Little Buffalo Basin field two 90-hp. gasoline driven piston type pumps are installed to pump oil into the line.

The line is designed for a maximum operating pressure of 1400 lb. As there are crudes of several viscosities being pumped, capacity of the line varies accordingly. For the most part viscosities are rather high. At 30°F., average winter pumping temperature, viscosities of the various crudes are as follows: Elk Basin Tensleep sand, 185 seconds saybolt; crude from the Tensleep sand of the Oregon Basin pool, 1200 seconds saybolt; Gebo crude, 310 seconds, and Little Buffalo Basin crude, 6500 seconds.

Line inspection. The line was designed so that the fiber stress of the pipe would not exceed 24,000 lb. To assure a sound line Stanolind provided a group of 8 inspectors for each of the three spreads. Among its personnel each group had an inspector for the following operations: Bending, ditching, pipe cleaning, coating, lowering in, and backfilling; for welding there were two inspectors.

Contractors. Laying of the line was divided into three jobs. Jobs 1 and 2, a total of 147 miles, were contracted to I. C. Little of Dallas, Texas, and job 3, 85 miles, to Sharman and Allen of Houston, Texas.

★ ★ ★

A SHARMAN AND ALLEN SPREAD

IN WYOMING

ON STANOLIND PIPE LINE COMPANY'S
12" ELK BASIN to CASPER LINE

SHARMAN AND ALLEN

General Contractors

OIL • GAS • GASOLINE • WATER • PIPELINES

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The Longest Drill Stem in the World is

HYDRIL

Standard Oil Co. of Calif.
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16,107 feet on Dec. 11, 1944

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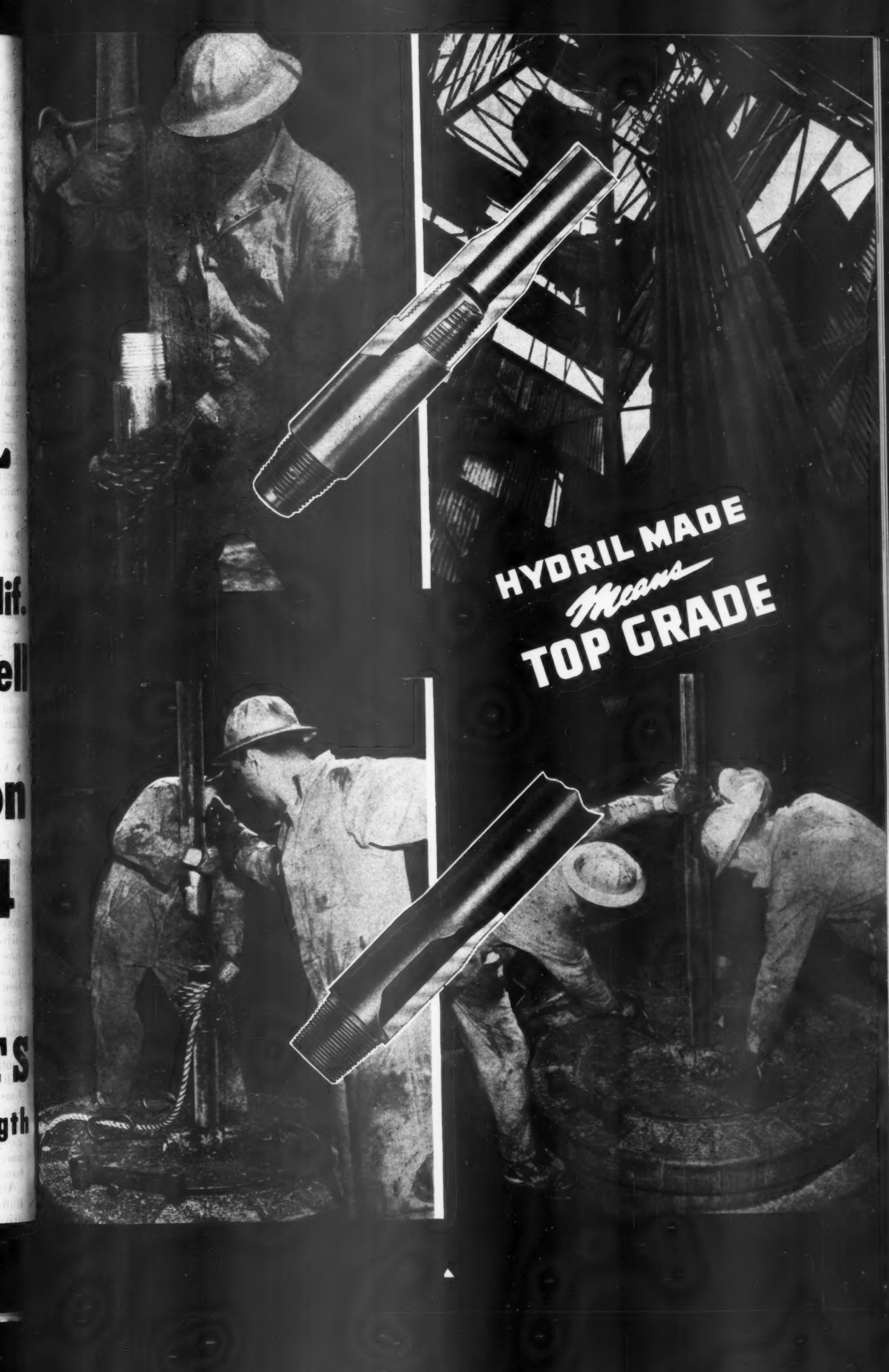

HYDRIL MADE
Means
TOP GRADE

GO-DEVIL STARTING DEVICE

EXCLUSIVE As a result of difficulties encountered recently in the internal cleaning of United Gas Pipe Line Company's Webster-Sterlington 20-in. pipe line, O. I. Corwine, a welder in the Sarepta field of United's Shreveport district, has developed an idea to ease the task of inserting a scraper or diaphragm plug in the line in preparation for a "Go-devil" run.

Although jacking and bumping methods have been normally successful on smaller lines, the difficulty of starting the heavier cleaners in large pipe suggested the use of a truck and winch line, of necessity already in place, as a means to performing this initial operation more quickly and easily.

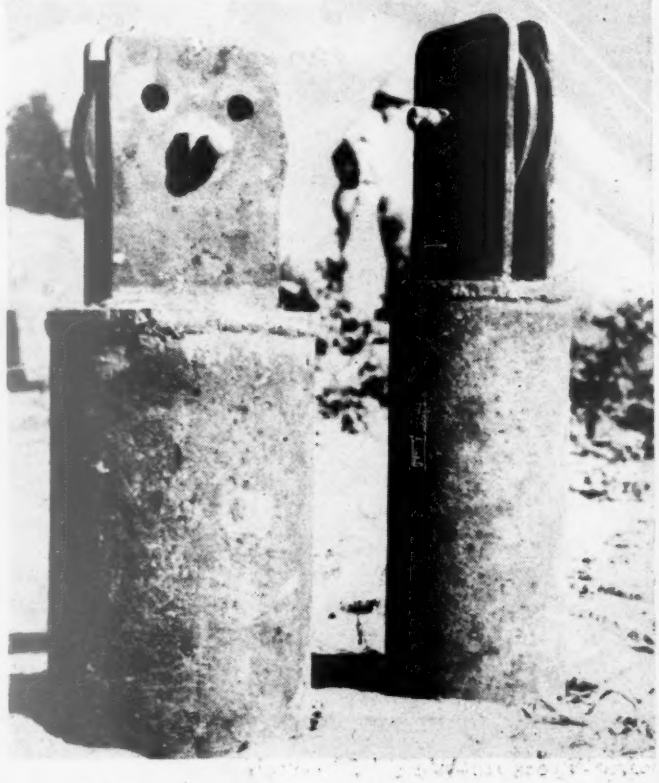
Corwine designed a pulley and cap arrangement, tentatively called a "cap jack," that can be used with the winch line without moving the truck that has been previously spotted to raise the pipe.

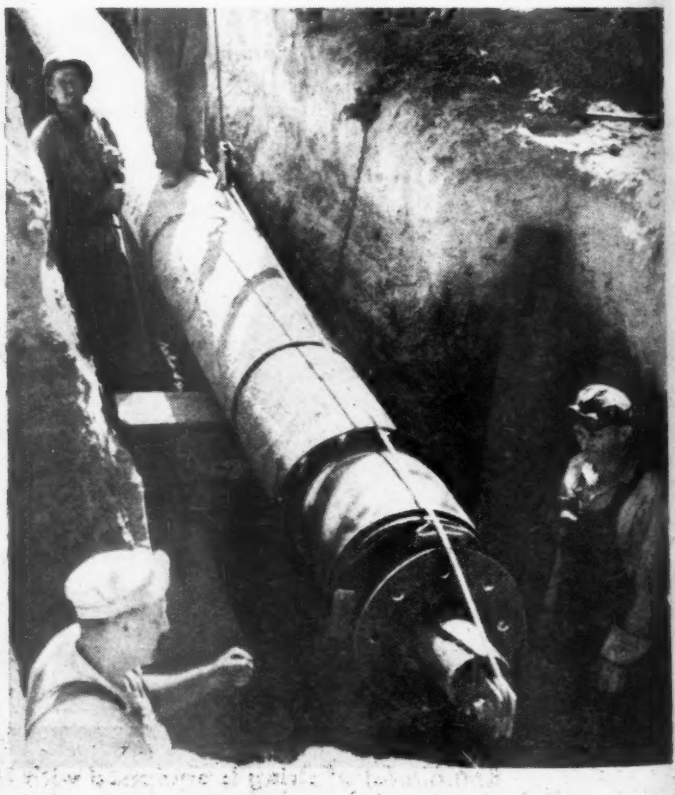
The first cap jack, used successfully on the Webster-Sterlington line job, was built of junk material on hand. It consists of a 14-in. length of pipe of sufficient diameter to slip over the tail piece of the cleaner, a flat piece of iron to form a cap over one end, two flat pieces of iron to serve as pulley mountings, and a 6-in. pulley wheel taken from an old, discarded block.

The nose of the scraper is put into the end of the pipe, and the cap is placed over the back end of the scraper core. A chain is wrapped around the pipe in line with the block on the "A" frame of the truck and a snatch block is hooked into the chain. The winch line is then threaded through the block, passed down the top of the pipe line, over the pulley wheel on the cap jack, and back under the pipe to a point about 3 ft. from the cap where it is tied around the pipe.

The truck driver then reels in his winch line, pulling the cleaner into the pipe, after which the line is removed and the cap jack lifted off. In this manner the plug is inserted in the line well beyond the end of the pipe and is ready for the truck to lower the pipe for it to be sleeved, the entire operation taking not more than 5 minutes.

Cap jacks of two sizes were made for use on the Webster-Sterlington cleaning job: One for the scraper and one for the plug. Each was approximately 21 in. in overall length. ★★★





***Right*—O. I. Corwine, welder in Sarepta field, displays cap jack he developed for inserting go-devil scrapers and plugs in large size pipe lines. *Far right*—Scraper is inserted well into pipe line and truck is already in place for lowering pipe to be recoupled. *Below*—Two of Corwine's jacks used on internal cleaning job for Webster-Sterlington line. Six-in. pipe was used in one; 4-in. in another. *Below, right*—A slight pull on winch line inserts the cleaner quickly and easily.**

We, like the entire industry for the past several years, have been expending our utmost effort toward the capping of this international blowout that has had for its purpose the destruction of the civilized world.

At this season of the year, we pause for a moment to utter a simple prayer for the day when our efforts and the power of the God-given natural resources, oil and gas, can again be turned to constructive, rather than destructive, endeavor.

GRAY
TOOL COMPANY
HOUSTON

AVIATION ENGINE LUBRICANTS*

By **F. L. MILLER**, Standard Oil Development Company
Assistant Director, Esso Laboratories

In addition to special fuels, modern aviation engines require specially selected lubricating oils. The functions of the oil are to lubricate the various engine parts and to help remove the tremendous amount of heat generated by the combustion of the fuel. For this service high quality oils, resistant to oxidation, sludge formation, and ring sticking, are required, both to prevent engine failures, which may have serious consequences in aircraft operation, and to improve engine cleanliness, which is desirable to extend the periods between engine overhauls. At the same time, with aerial warfare on its present gigantic scale, it is imperative that these oils be made available in greater volumes than ever considered before.

Research on a wide scale has made it possible generally to fulfill both the quality and quantity requirements. Until less than five years before the entry of the United States into World War II, the country was essentially limited to a single type crude, Pennsylvania, for its aviation lubricants. Were the country still dependent on this one source of aviation oil, the aerial war would be seriously handicapped, even if supplies of quality lubricating oils for commercial and civilian purposes were sharply curtailed. Fortunately the development of new solvent treating techniques and their general application in the petroleum industry have made possible the production of oils, not only of equal or superior quality, as compared to the Pennsylvania oils, but also in extremely large volume so that the war effort has been supported without any significant sacrifice in either the quality or the supply of lubricants on the home front.

The Jersey company early recognized the high level of quality that was needed in aviation engine lubricants and the possibility of applying the newer refining methods in obtaining this quality. To this end, an extensive program of full-scale engine tests was started in 1936 under a contract with the Pratt and Whitney Company, utilizing their equipment and some of their personnel. This program, the only one of its kind undertaken in this country, provided an excellent background of information about lubricating oil performance characteristics and demonstrated that definite differences in the quality of aviation lubricating oils existed and could be determined with a reasonable degree of certainty. It further demonstrated that with the new propane solvent treating techniques developed by the Jersey company good quality aviation oils could probably be made from many crudes, some of them previously considered unsatisfactory for lubricating oil manufacture, and that outstanding products could be made from certain selected crudes. A few data in Table 1 illustrate the nature of the results that were obtained. Fig. 1 shows representative pistons from the runs on the different oils.

By the time the war intervened in 1939, the program had resulted in the development of an oil, the third oil in the foregoing table, of especially high quality. It received an excellent rating on the official approval tests performed by the Wright Aeronautical Company and performed excellently in all other engine approval tests to which it had to be submitted. Its performance in actual service has been equally as excellent as that shown in the different full-scale engine tests.

It is becoming evident, however, that, as good as some of the present oils are, there will be a need for oils showing even better performance in the future. Already difficulties with ring sticking, increased sludge, etc., are being encountered with the oils now generally available. This is particularly true with the latest and most powerful engines, especially under combat conditions where severity of operation is much greater than ever before. Furthermore, with oils of high enough quality certain mechanical changes in the engine to improve operations might be permitted. For example, one possibility would be the reduction of cooling area to improve utilization of the engine's power. It has been estimated by aeronautical engineers that the useful power could perhaps be increased about 15 per cent at high altitudes, less at lower altitudes, by allowing the cylinder temperatures to increase 50 °F. All difficulties, such as sludge deposits, ring sticking, etc., naturally become greatly aggravated under these more severe conditions and demand the utmost stability and performance in the oil.

Extensive research, including small single cylinder and full-scale engine tests and flight tests will be necessary to determine what special qualities are needed in these new oils and how to obtain them. The work that has already been done indicates that significant improvements are possible. The available evidence, however, indicates that we

*Presented at opening of Aviation Engine Fuel Test Unit, Bayway, New Jersey, September 19, 1944.

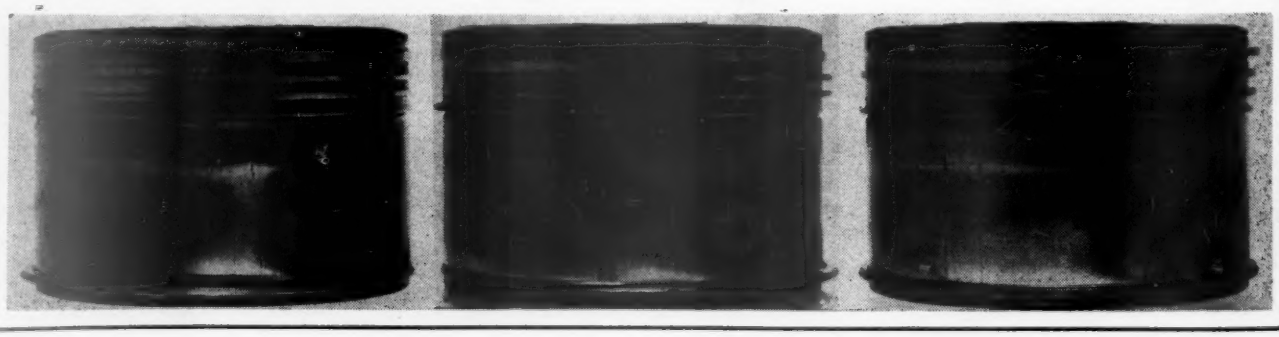
TABLE 1

Oil	Engine demerit ratings* Overall	Slude deposits
Conventional Pennsylvania	3.0	3.5
Solvent extracted Pennsylvania	2.3	2.0
Solvent extracted Mid-Continent—(Esso aviation oil)	1.7	0.5

*Demerit ratings—The lower the figure the better the cleanliness or performance.

Fig. 1. AVIATION OILS
Performance in Pratt and Whitney Hornet engine test.

Conventional Pennsylvania aviation oil		Solvent extracted Pennsylvania aviation oil		Solvent extracted Mid-Continent aviation oil (Esso aviation oil)	
Overall deposits 3.0	Sludge deposits 3.5	Overall deposits 2.3	Sludge deposits 2.0	Overall deposits 1.7	Sludge deposits 0.5



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Complete *mechanical details* on Dreadnaught Drilling Crown and Traveling Blocks will be found in Volume 1 of the Composite Catalog or descriptive literature will be sent on request.

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have probably closely approached the upper limit in the quality that can be provided through selection of crude source and method of refining, and that the improved performance characteristics will have to be obtained by other means. One means of obtaining the superior performance will undoubtedly be the use of small quantities of certain types of synthetic commercial additives. Some of these, particularly the detergent type additives, have been widely adopted for the manufacture of heavy duty motor oils such as those used by the armed forces, and have shown unusual ability to prevent ring sticking and to maintain engine cleanliness. One product, Paranox 56, has shown considerable promise for use in aircraft engines. This is illustrated by data given in Table 2 and in Fig. 2. In Table 2 comparative data are given on the performance of the extracted Mid-Continent oil referred to in Table 1 and its blend with Paranox 56 in a full-scale Wright engine and in a small-scale laboratory single cylinder engine. Fig. 2 illustrates the conditions of the piston from these two engines.

Numerous full-scale engine tests on several different kinds of engines and extensive flight tests of over 250,000 hr. in commercial airlines and in combat ships have further confirmed the excellent performance, particularly with regard to ring sticking and ring zone condition, of the oils containing this additive.

Another possible method of obtaining the desired improved qualities may be through the development of oils that are partly or wholly synthetic in nature. Several such products, utilizing low molecular weight olefins, cracked wax olefins, or even distinctly novel raw materials, have been made and some have shown a certain degree of promise. One made a number of years ago by the polymerization of cracked wax was offered commercially for a time and was tested rather extensively. A second material that has shown promise is the voltolized fatty oil concentrate that was used rather widely in some parts of Europe prior to the present war. It is rumored that the Germans are using synthetic oils in their aircraft and voltol oils in their ground vehicles if not in aircraft. Some idea of the probable performance characteristics of the synthetic and voltolized oils may be gained from the full-scale and small-scale engine data summarized in Table 3. Photographs of the pistons from the small-scale engine tests on the synthetic oil and a conventionally refined Pennsylvania oil are shown in Fig. 3.

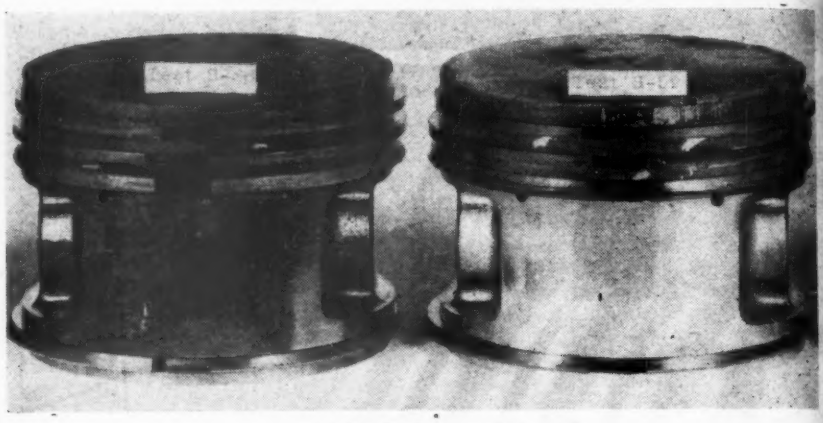
However they are obtained, these better performance qualities should be of distinct value to the aircraft industry. First, they should permit the development of even more powerful engines or operation under more severe conditions or both. This would be of importance to both military and commercial aviation. Second, they should offer greater resistance to ring sticking, which is more common in certain European engines than in American, and to sludge formation. To military aviation this should at least offer greater liability of operation. To commercial avia-

Fig. 2. AVIATION OILS
Effect of detergent additives on performance.
Overall demerit ratings

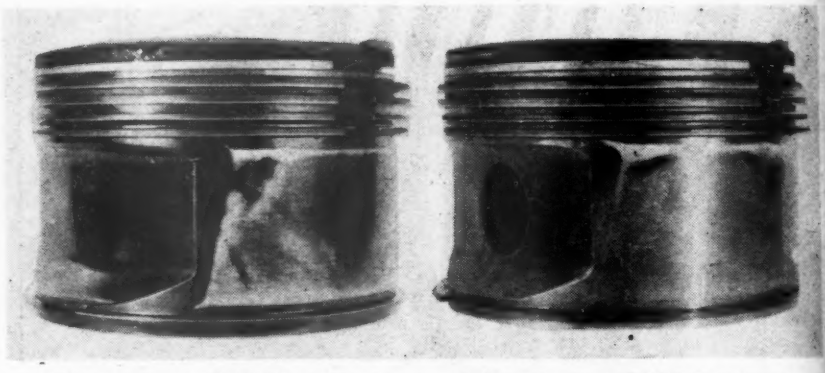
Laboratory single cylinder engine No. 1		Wright Cyclone engine	
1.8	0.7	2.2	1.3

Pistons from engine tests

Laboratory single cylinder engine No. 1



Wright Cyclone engine



Solvent extracted Mid-Continent aviation oil.

Solvent extracted Mid-Continent + Paranox 56.

Fig. 3. AVIATION OILS
Performance of synthetic oil in laboratory—single cylinder engine No. 2.

Conventional Pennsylvania aviation oil. **Synthetic aviation oil.**

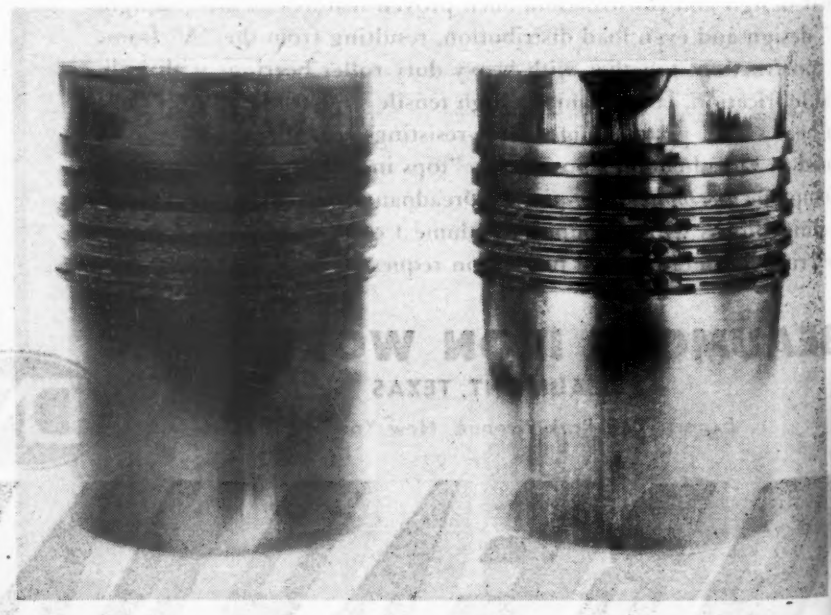


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TABLE 2

Lubricant	Engine demerit ratings: Full-scale Wright engine		Laboratory single cylinder engine No. 1
	Overall	Sludge deposits	Overall
Extracted Mid-Continent oil—(Esso aviation oil)	2.2	1.6	1.8
Extracted Mid-Continent oil plus Paranox 56	1.3	1.2	0.7

TABLE 3

Lubricant	Engine demerit ratings: Full-scale Pratt and Whitney engine		Laboratory single cylinder engine No. 2
	Overall	Sludge deposits	Overall
Conventional Pennsylvania	3.0	3.5	2.0
Solvent extracted Pennsylvania	2.3	2.0	1.54
Solvent extracted Pennsylvania plus Voltol	1.6	0.3	1.26
Synthetic oil (from cracked wax)	....	....	0.62

tion it should permit longer periods between relatively costly overhauls. Presently, overhaul periods are predicated on one or more of the following factors:

1. *Ring and cylinder wear.*
2. *Ring sticking.*
3. *Sludge accumulation.*

In many cases, particularly in American commercial airlines, continued improvement in the engines and the lubricating oils have combined to raise the overhaul periods to as high as 500 to 600 hr. or more. The K.L.M. lines in Europe were reported, prior to the war, to be above 750 hr. employing a Voltol blend. Nevertheless, rather large differences still exist as evidenced by the sharply contrasting situation that exists in two large international airlines. One line, employing engines relatively free from ring sticking tendencies and a high quality lubricating oil, has succeeded in reaching overhaul periods in the neighborhood of 600 hr. and is aiming at still longer times with a likelihood of success. The second, with engines more likely to stick rings and with an oil of average competitive quality is forced to overhaul its engines at about 200 hr. An improvement in oil quality that would permit the second operator to double his overhaul time should have an incremental value to him upwards of $1.60 per gal. of oil purchased (see Fig. 4), assuming average oil consumption, oil change practices, oil prices, and engine overhaul costs. Similarly, an extension of the overhaul period to 1000 hr. from 600 hr. should have an incremental advantage of around 47 cents a gal. to the first operator. If oil changes could also be eliminated another 7 cents a gal. would be added to the oil's value.

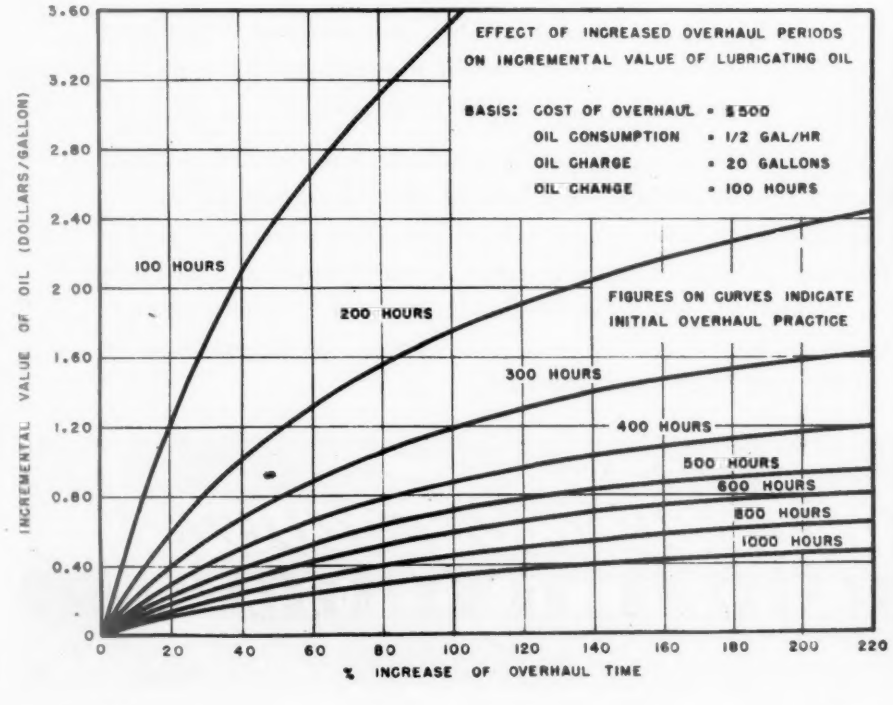
There are numerous other lubricating oil problems in the aircraft field that are receiving a great deal of attention and research effort. Among the most important of these are:

1. *High V. I. hydraulic oils.*
2. *Special lubricants for instruments and aircraft accessories.*
3. *Rust preventives and rust preventive engine oils.*
4. *Special greases.*
5. *Gear lubricants.*

All occupy a prominent place in the operation and maintenance of aircraft, and quality is equally as important a consideration to them as it is in the case of the fuels and engine lubricants.

★ ★ ★

Fig. 4



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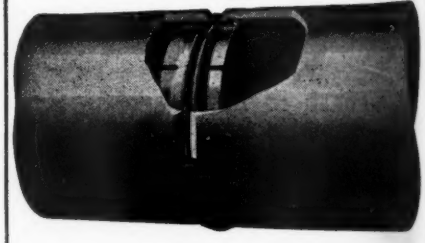

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CONTROL OF MUD WEIGHT IN DRILLING WILDCAT WELLS

By **C. C. PRYOR**, *Associate Editor*

EXCLUSIVE AMONG the numerous problems confronting the contractor engaged in drilling wildcat wells is proper mud control. Despite rapid advances in the technique of mud control made by research engineers of the petroleum industry, drilling mud and chemical company engineers, and university research, drilling mud is still a major factor in wildcat drilling. Research has solved the problem of drilling mud behavior in the hole under certain conditions and its response to various treatments, enabling the driller to maintain mud having the correct characteristics for drilling.

It has only been in recent years that many of the discoveries of the mud research laboratories have been put into practical operation in drilling. The field drilling mud engineer, specially trained for his work, is responsible for bridging the time gap between research and field application. As a result, the number of blowouts from the use of improperly maintained drilling mud has sharply declined.

The wildcat or semi-wildcat drilling well is the most difficult assignment of the mud engineer and obviously one on which he is most valuable. Lack of complete geological data places the responsibility for safe and economical drilling of the well largely on the use of the correct drilling mud. Therefore, the mud engineer must keep a close check on the characteristics of the drilling mud and maintain materials and equipment to anticipate any emergency.

Wells drilled in the Gulf Coast area of Texas and Louisiana almost always encounter high pressure gas sands, flows of salt water, heaving shale beds, and highly porous formations. Obviously, close control of wildcat or semi-wildcat wells drilling in this area is imperative with the most important drilling mud characteristic being that of weight.

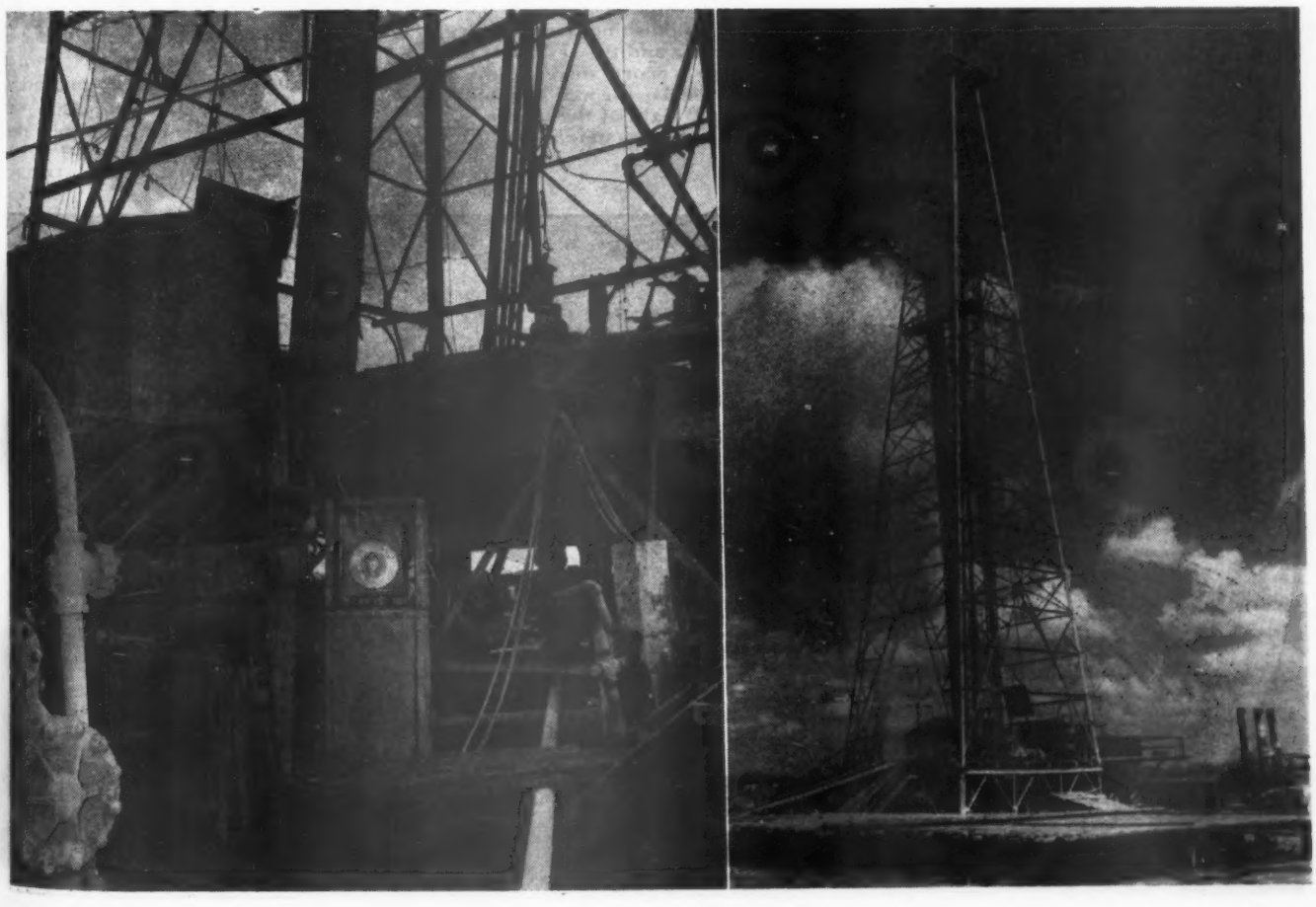
A typical example of the care and precaution exercised in drilling Gulf Coast area wells is the Standard Oil Company of Texas well, Garcia No. 4, a semi-wildcat in Brooks County, Texas, drilled by The Trinity Drilling Company.

Left—**Automatic mud weight machine recording unit on the Garcia No. 4 in the foreground.** *Right*—**Trinity Drilling Company rig drilling the Garcia No. 4, Brooks County, Texas.**

Immediately previous to the drilling of this well, the Chavana No. 1 was drilled 4000 ft. east of the Garcia. The Chavana had blown out and caught fire, destroying the rig. Drilling of the Garcia was begun after a careful study of the drilling mud data from the Chavana.

The casing program of the Garcia No. 4 included 172 ft. of 16-in., 65-lb. casing cemented with 325 sacks; 10¾-in. casing at 2507 ft.; 6927 ft. of 7⅝-in., 33.7-lb. casing with 700 sacks, and 5½-in., 17-lb. casing cemented at 8074 ft. with 100 sacks of cement.

Drilling of the Garcia No. 4 proceeded without incident to a depth of 6760 ft. Coring was begun at a depth of 5656 ft. for the purpose of correlation with the Chavana No. 1 and was carried on intermittently to 6760 ft. Mud used to this point weighed 11.0 lb. and had been increased to 11.6 lb. while coring to 6760 ft. It was the intention of the operator to increase the mud weight sufficiently to control the Chavana sand, which was at an expected depth of approximately 7010 ft. When the operator went into the hole with a wire line and an overshot at 6760 ft. to recover the core barrel the well blew out before the core could be recovered. The well was killed with mud and efforts were begun to recover the string of 4½-in. drill pipe. During this time an extra mud pit having a capacity of 1000 bbl. was dug, extra pumps were installed, and a 100-bbl. steel tank of mud was prepared with high aquagel, mica, and jelflake content. When circulation was lost, mud from the 100-bbl. tank was pumped into the well and forced into the thief formation under



Weighing unit of the automatic mud weight machine connected to the mud returns ditch. Recording unit is at the right.

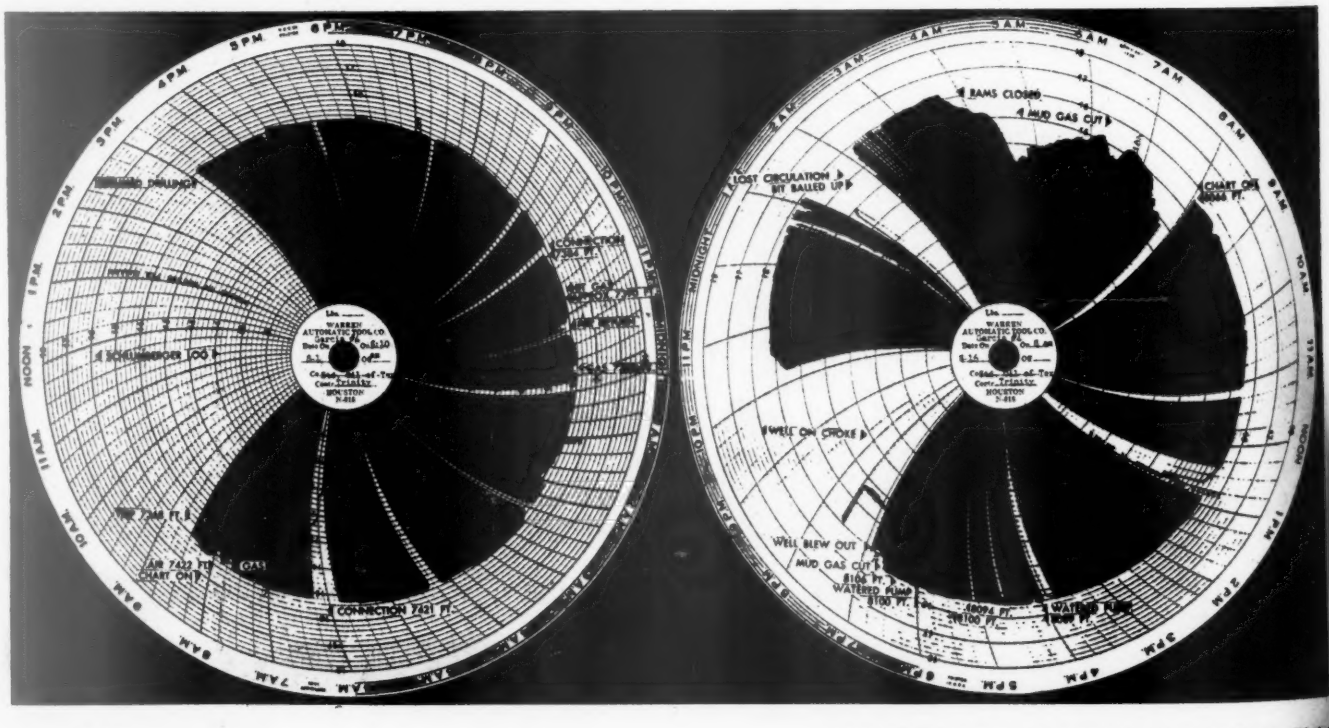
pressure and circulation regained. While attempting to recover the drill pipe the mud weight was increased to 14 lb. and then because of lost circulation was reduced to 12.5 lb. At this point in the operations an automatic mud weighing machine was installed to provide a continuous graphic record of the weight of the drilling mud as it was evident that correlation between the Chavana and Garcia was not dependable, leaving the operator with no indication of the number or depth of high pressure gas sands to be drilled. After attempts to pull the stuck drill pipe, the operators managed to back off 2500 ft. of the pipe. An additional 3500 ft. was recovered by washing over and cutting with outside cutters about 430 ft. each trip. The fish was not recoverable below 6290 ft. A 200-ft. cement plug was set for sidetracking the obstruction at this depth, but the operators were unable to drill off the plug into the sidetrack. The entire plug was drilled in the sidetracking attempt and the well began to kick with 12.2-lb. mud due to gas coming from the bottom of the hole. Then the well was closed in and the mud weight increased to 12.5 lb. and a second cement plug 300 ft. in length was set and sidetracking began, but a twistoff of the drill pipe occurred at 6245 ft. A third cement plug was spotted at 6255 ft., a whipstock was set, and sidetracking was begun at 5833 ft. The well was drilled to the sand where the blowout had occurred. Immediately before reaching the sand the mud weight was increased to 13.2 lb., other characteristics were viscosity 58, initial gel strength 4, cake thickness 3/32 in., and pH 9.5. The water loss was held to 8 cc.

Drilling the 80-ft. thick high pressure gas sand the second time was accomplished without incident. After drilling down to 6760 ft. the first 10 ft. of the sand was drilled in sections of 1 and 2 ft. After each section the pumps were shut down, the drill pipe was raised to invite swabbing, and the weight of the mud returns watched on the automatic mud weighing machine, which provided the exact weight of the mud at about 37-sec. intervals. The ultimate mud weight to be used for drilling through the Chavana sand had been set at 15.0 lb.; however, at 6912 ft. circulation was lost with 13.8 lb. mud while attempts were being made to bring the weight up to 15.0 lb. The mud was cut to 13.3 lb. and circulation was regained. The well was drilled 15 ft. to a shale break and the string of 7⅝-in. casing set at 6927 ft.

The cement was drilled out and the mud raised to 15.2 lb. in anticipation of the Chavana sand, which was expected at about 7010 ft. There was no indication, however, that the Chavana sand was drilled; an open hole log later indicated that the sand was passed at 6987 ft. and was hardly developed. The 15.2-lb.

Two charts made during drilling of the Garcia No. 4 on the automatic mud weighing machine. Fig. 1 illustrates sensitiveness of machine by establishing circulation time from air and gas. Fig. 2 is a continuous record of the mud weight on the day the well blew out at 8106 ft. Weight of the mud was recorded approximately every 37 seconds.

FIG. 1 FIG. 2



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weight mud was used to drill to the total depth of the well.

A striking illustration of the value of a mud weight recorder[1] in preventing blowouts is provided by the following incident and is shown in Fig. 1.

Drilling at 7384 ft. a joint of drill pipe was added to the string at 9:55 p. m. The air resulting from the connection returned to the surface at 11:10 p. m. and was registered on the automatic mud weighing machine chart. (Fig. 1). Circulation time had previously been established at 1 hr. 15 min. At 11:50 p. m. the mud machine recorded a second drop in mud weight on or about the time the hole had been drilled to 7395 ft. It was estimated that a gas sand had been encountered at approximately 7390 ft., which was about an hour previous to its arriving at the surface. The weight of the mud dropped to 15.1 lb. and was immediately raised to 15.3 lb. An electrical log showed a sand from 7387 to 7400 ft., which was later tested. Thus, the value of the mud weight recorder is evidenced, first by providing a continuous record of the mud weight coming out of the flow line, and second, by permitting instantaneous interpretation of this record by a mud engineer in constant attendance so that corrective steps may be taken in time to keep the well under control.

From 7620 ft. to 7674 ft., a gas sand was drilled with the mud weight at 15.3 lb. sufficient to hold the pressure. At 8094 ft. another high pressure gas sand was encountered one afternoon at 5:15 p.m. that put the crew on the alert because the bit made 6 ft. of hole in 20 min. as compared to the rate of 2 ft. per hr. made before. The operator then decided to circulate for a period with members of the crew posted at the blowout preventer controls and at the automatic mud weighing machine to watch the weight of the mud coming out of the hole.

About 35 min. later, at 5:50 p.m., the mud pump was shut down to be checked and the mud coming from the hole continued to flow in a small stream to the pits, as is reflected on the mud chart (Fig. 2). Fifty-five minutes later, at 6:45 p.m., samples showed the mud to be gas cut as the mud machine recorded the weight as 14.6 lb. and then showed an increase in the weight to 14.75 lb. (Fig. 2). Ten minutes later the well headed, blowing mud down the mud ditch and also blowing hard against the rotary table. The kelly had been picked up out of the hole at the first warning that the high pressure sand was being drilled. When the well began to blow the rams of the blowout preventer were closed and the well put on a ½-in. choke. Drill pipe was rotated to prevent bridging and sticking. When the well had blown for 15 min. it began to subside and at 7:40 the mud weight was 14.6 lb. The mud pump was again shut down and the mud continued to flow at the same rate as when the pump was running. It was apparent that the flow was keeping up with the mud pump pressure of 1200 lb. Five minutes later the well began to blow a second time with greatly increased force and continued until 8:45 p.m. when it began to subside. Weighting materials had been added to the mud since 6:45 p.m., but at 9:15 p.m. the well was kicking 15 lb. mud out of the hole. The time and condition of the well and drilling mud from the mud engineers' records and the chart (Fig. 2) as follows:

9:45 p.m.—mud weight 14.7 lb., no gas. Shut pump down, no decrease in flow of mud through line on ½-in. choke.

10:15 p.m.—mud returns flowed through 2-in. line. Well losing mud.

10:30 p.m.—losing mud at high rate.

10:45 p.m.—jetting mud from reserve mud pit, weight 14.8 lb. Mud returns weight 15.2 lb. Mud continued to flow with pump shut down.

12:00 midnight—jetted more mud from reserve pit. Mud weighs 15.6 lb. into well and 15.6 out. Mud flowing when pumps shut down with 200-lb. pressure on pump gauge.

1:00 a.m.—weight of mud returns 15.8 lb. Pressure on drill pipe with pump shut down, 300 lb. Mud still flowing in small but steady stream. Losing mud in the hole. Opened rams and picked up pipe that was still free.

1:30 a.m.—lost circulation. Pump pressure 1100 lb.

1:45 a.m.—picked pipe up and found mud at flow line.

2:15 a.m.—raised and lowered pipe in the hole and obtained small returns with 500-lb. pump pressure. Then raised and lowered pipe enough to pass collars, which increased circulation.

3:00 a.m.—losing less mud (1-in. drop in mud pit in 15 min.) with pump pressure 500 lb.

3:45 a.m.—mud returns weighing 16.0 lb. for last 1½ hr. Mud entering well at about 15.0 lb. One inch gain in mud level in pit. Pump pressure 750 lb. Closed rams and put well on 2-in. flow line. Well flowed hard; mud weight 15.2 lb.

4:30 a.m.—mud pit level still rising.

4:45 a.m.—mud pits holding level. Opened rams.

5:00 a.m.—pit level down ½ in. Pump

[1]Warren Automatic Tool Company.

TABLE 1

Sand section, ft.	Mud weight	Pressures			Prod.*	condensate G.M.C.F.	sp. gr.,
		G. H.	S. I.	Flow			
6810-6815	13.2	4800	4000	3200			
7387-7400	15.2	5900	....	....			
7620-7674	15.3	6200	5500	5300	4 MM. cu. ft.	3.45	0.72
8074-8106	17.2	7200	6800	....	9.8 MM. cu. ft.	1.55	0.74

*Estimated. All tests made with ¼-in. choke on top and bottom of 2-in. tubing.

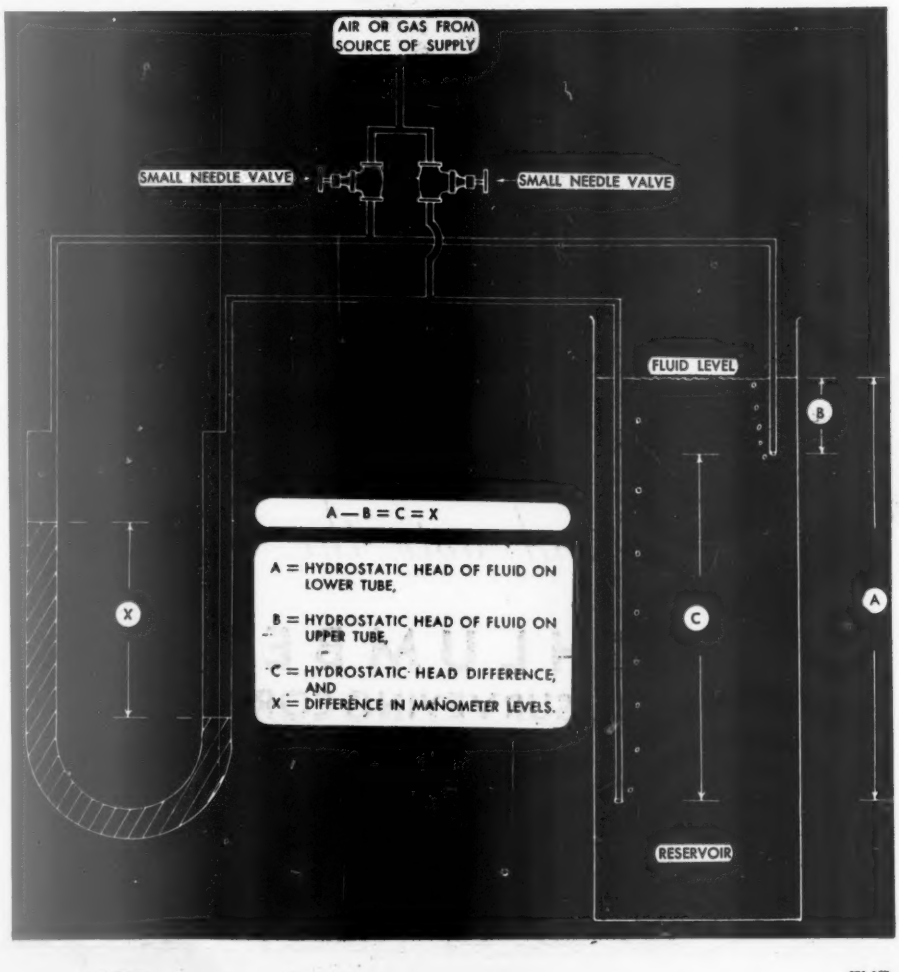
AIR OR GAS FROM SOURCE OF SUPPLY
SMALL NEEDLE VALVE
SMALL NEEDLE VALVE
FLUID LEVEL
B
A — B = C = X
A = HYDROSTATIC HEAD OF FLUID ON LOWER TUBE,
B = HYDROSTATIC HEAD OF FLUID ON UPPER TUBE,
C = HYDROSTATIC HEAD DIFFERENCE, AND
X = DIFFERENCE IN MANOMETER LEVELS.
X
C
A
RESERVOIR

FIG. 3 is a sketch illustrating the basic principles of the automatic mud weighing machine.

Baash-Ross News

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We've added 2 new improvements to BAASH-ROSS Drill Collar Slips

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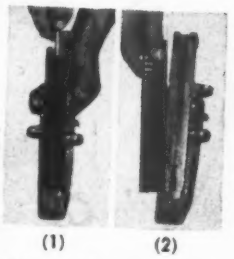
FORGED STEEL BODIES

As a result of recent manufacturing advancements, each body segment in Baash-Ross Drill Collar Slips is now made of tough forged steel—steel that is shaped under giant hammers to produce a denser and stronger body than even the top quality cast construction formerly used. This development gives Baash-Ross Drill Collar Slips still greater resistance to the impacts of rough rig service and to the stresses of maximum slip loads.

CORROSION-PROOF LINER RETENTION

The method by which the liners are locked in Drill Collar Slip bodies is both simple and unusually fool-proof. To replace a worn liner it is only necessary to remove a cotter key and pull out the liner retaining key (1), whereupon the liner is then readily removed (2). To make this operation even easier, the liner retaining key is now made of *stainless steel*. This eliminates the possibility of any rust or chemical corrosion occurring on the retaining key and assures quick, trouble-free replacements at all times.



(1) (2)

BUT [redacted] THE MOST IMPORTANT ADVANTAGE IN BAASH-ROSS DRILL COLLAR SLIPS!

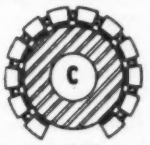
WHILE the improvements outlined above are important, the essential feature to remember about Baash-Ross Drill Collar Slips is that they fill a basic need unmet by any other make or type of slip ...*the problem of safely supporting a string of drill collars in the rotary table.*

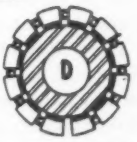
If you are now using fixed-diameter slips to support drill collars in the table you are risking a costly difficult fishing job every time you do it. *Why?* Take a look at these sketches and we'll show you...

▶Drill collars differ from drill pipe in that their diameter is constantly changing—steadily reducing as the surface grinds against the raw fresh-cut walls of the hole directly behind the bit. On drill *pipe* this wear is usually absorbed by protectors—or at least by the tool joints—so that the pipe surface opposite the slips maintains its full diameter.

Since drill collars have no such protection, the area where the slips take hold is a different diameter after almost every trip into the hole. *And because this area is hard heat-treated steel, it is absolutely essential that accurate slip fit be maintained to assure a safe, uniform grip.* But fixed-diameter slips that fit the collar when new (A) are unable to change curvature as the collar wears. They become steadily less and less effective (B) until finally they fail to hold and the string is lost down the hole.

▶*Baash-Ross Drill Collar Slips are specially engineered to overcome this problem.* They are made up of many *narrow* segments flexibly hinged together so that they w-r-a-p around the collar like a chain tong, giving the same full grip whether the collar is new (C), worn (D) or even out-of-round!



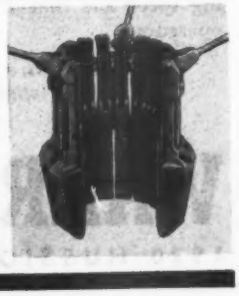


Flexibly-linked narrow segments of Baash-Ross Drill Collar Slips automatically compensate wear, giving same full grip whether collar is new, worn or out-of-round!

Fixed-diameter slips that fit new collar

... lose grip as the drill collar wears!

No other slip gives you the vital protection that the Baash-Ross Drill Collar Slip does. It is one of the most important investments you can make toward greater safety, fewer fishing jobs in your drilling operations. Available in sizes to fit all collars 3¾" to 8¼" in diameter ... and in two types, "Regular" (above) and "Long" (right). The "Long" type is specifically recommended for use in conjunction with the Baash-Ross Safety Clamp for double protection. GET THE FULL PARTICULARS FROM YOUR NEARBY BAASH-ROSS REPRESENTATIVE, SEE PAGE 264 OF YOUR COMPOSITE CATALOG, OR WRITE!



speed slowed and pressure lowered from 1000 lb. to 700 lb. Mud weight varying from 16 lb. to 13.6 lb.

6:30 a.m.—mud loss stopped, weight dropped to 14.6 lb. Pump pressure increased to 750 lb.

7:30 a.m.—mud weight varying from 14.4 lb. to 15.2 lb. Well not attempting to blow.

7:45 a.m.—well attempted to blow out. Rams closed.

8:30 a.m. to 9:30 a.m.—well flowed on ½-in. choke.

10:00 a.m. — mud returns 15.4 lb. Rams opened.

During the next 8 hr. the mud weight was increased to 16.5 lb., which supplied a hydrostatic head sufficient to hold the gas pressure estimated to be in excess of 7000 lb. per sq. in. until the operator attempted to rotate the pipe when the well began to flow. The mud weight was raised to 16.6 lb., but a decrease of 8 in. in the pit level indicated that the hole was taking mud. The weight of the mud had cut back to 16.1 lb. and later equalized at 16.2 lb.

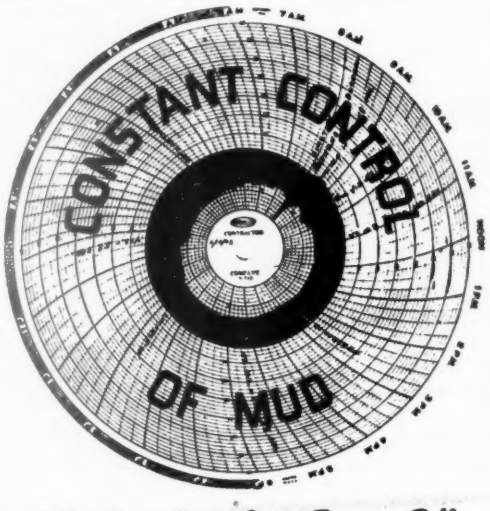
Attempts to establish circulation during a third day were unsuccessful. The mud weight was either insufficient to control the gas pressure for further drilling or circulation was lost. When it became evident that the mud weight necessary for circulation and control of the well could not be reached, the operator set a bottom-hole plug with 15 sacks of cement. Later the 6⅝-in. open hole was reamed without difficulty with 16-lb. mud. The top of the plug was found at 8074 ft. and a full string of 5½-in., 17-lb. casing was cemented with 100 sacks of cement. The pipe stuck when landed on the bottom. circulation was lost and not regained.

After the casing had been tested with 2150-lb. water pressure the hole was drilled out to 8057 ft. and a radioactivity log was run that found a sand at 8050 ft. The mud weight was then raised to 16.6 lb. and the hole reamed to the bottom at 8106 ft., which resulted in the well blowing a large volume of gas. An increase in mud weight to 17.0 lb. then to 17.2 lb. proved sufficient to hold the sand in check and the operators began testing the various gas sands drilled.

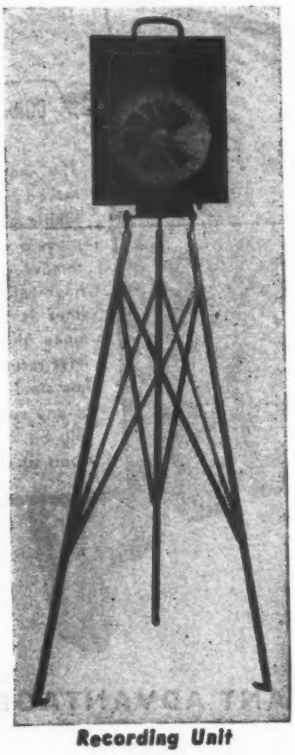
The four high pressure gas sands drilled in the well are given in Table 1.

The high gas pressures and the apparently high porosity of the gas sands making it impossible to obtain the necessary weight and retain circulation required full attention of the field mud engineer and full use of all materials and equipment at his disposal. Among the important equipment available to the mud engineer was the automatic mud weighing machine. When the well was blowing mud from the hole and was put on the choke, the flow was still directed through a 2-in. pipe into the mud ditch ahead of the weighing mechanism of the mud machine (as shown in the photo) in order to provide a continuous record of the mud weight. Whenever the mud became gas cut and decreased in weight it was recorded by the machine as quickly as the mud reached the surface and flowed approximately 30 ft. down the mud ditch to the weighing mechanism. Thus close check on the mud weight was possible by use of the machine due to the speed, approximately 37 sec., with which it weighed and recorded. In addition, when the weight of the mud began to drop and there was possibility of a blowout, the record warned the crew in time for preparations that otherwise might not have been made. The change in mud weight recorded by the machine was directly responsible for alerting the crew immediately before the gas kick at 8094 ft. One man was stationed at the blowout preventer, two at the ram controls, and one at the automatic mud weighing machine recorder. Other members of the crew stood by for the emergency.

The basic principle of operation of the mud machine is that it measures the differential pressure required to introduce a flow of air or gas, at predetermined spaced elevations, as shown in Fig. 3, into a trapped column of mud. Then as the specific gravity of the mud varies, the differential pressure that is required to introduce the air or gas into the mud column will vary in direct proportion. These pressures are communicated through individual tubes to the recording unit, where it is recorded by a pen on a 24-hr. chart, calibrated directly in pounds per gallon. Arrangement of the mud column in the weighing unit is such that the mud enters and discharges by gravity. ★★★



"Mud-O-Graf"
offers
BLOWOUT PROTECTION

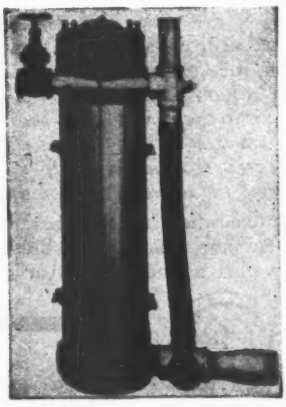

Recording Unit

Blowouts due to gas incursions, not being detected until of sufficient force to cause the well to kick, is minimized or eliminated, because the slightest variations in mud weight are promptly and accurately revealed for immediate correction.

The "Mud-O-Graf" automatically records, every 45 seconds on a 24-hour chart, the actual weight of the mud at that instant. With this information, the mud engineer can intelligently maintain uniform control of all of the mud in the system. As a result, weighting materials and chemicals are used more efficiently and economically, and the danger of blowouts is greatly reduced.

The "Mud-O-Graf" chart further indicates drilling speed and time required for all other drilling operations.

For descriptive data — see page 2974 of 1943-44 edition Composite Catalog.


Weighing Unit

WARREN AUTOMATIC TOOL CO.
1920 HUSSION • HOUSTON, TEXAS

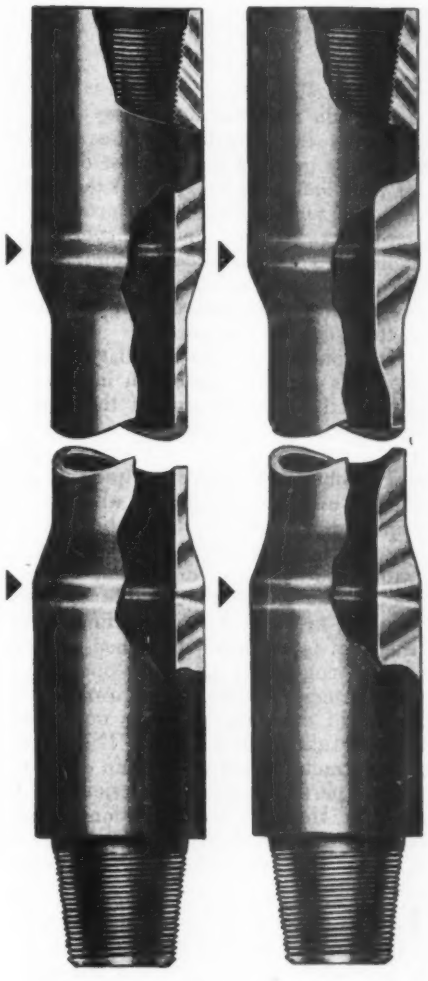
New Method of Butt Welding new Tool Joints on Used Drill Pipe in Field Shops

The Hydril "Ferrule-Weld" method of reconditioning drill pipe makes it possible for a field shop, with no special equipment, to butt weld new tool joints on used drill pipe, turning out as strong and accurate a job as factory reconditioning. In these days, with drill pipe like all other materials scarce and hard to get, the saving in time that pipe is out of service for repair is a very important factor to all drill pipe users. In addition to time saved in transportation, and the costs, the "Ferrule-Weld" method saves time in the field shop due to the speed with which a perfect alignment is achieved by means of the ferrule.

Although "Ferrule-Weld" is new to the drilling industry as a whole, it has been thoroughly tested over a period of years under all possible conditions.

The "Ferrule-Weld" method welds new pre-threaded and heat treated alloy steel box or pin tool joints on the upset end of used drill pipe. The important advantages of this method are: 1, "The Ferrule positions and holds the joint in line with the axis of the pipe during welding, assuring correct alignment of the threaded joint. 2, "Ferrule-Weld" joints are threaded on thread milling machines. The steel is carefully selected and the joints are as carefully inspected and gauged as the original tool joints. 3, "Ferrule-Weld" joints are made of suitable alloy steel, heat treated to produce long-wearing qualities. 4, Any desired type of thread can be applied. 5, "Ferrule-Weld" is a normal electric arc weld, made in the thick upset section of the drill pipe end.

The possibility of fatigue cracks is definitely eliminated because of the thorough penetration of the arc weld into the beveled faces of the joint, the upset and the Ferrule. The weld section is stronger than the body of the drill pipe.

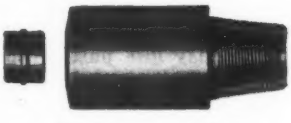


API Internal Flush "FERRULE-WELD" *Pin and Box Joints*

API Full Hole "FERRULE-WELD" *Pin and Box Joints*

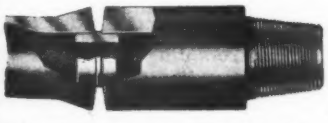
▶ *Indicates Location of "Ferrule-Weld"*

Steps in the "Ferrule-Weld" Method of Welding



1. *Ferrule and Joint*

The Ferrule is a low-carbon steel ring machined to fit tightly into the bore of the joint and the drill pipe upset, and having a slightly raised shoulder at right angles to the axis of the ring. The "FERRULE-WELD" joint is supplied threaded, heat treated, fully machined, and beveled for welding. "FERRULE-WELD" joints can be furnished with Ferrules pressed in place.



2. *Pipe Prepared Easily*

The pipe is prepared by cutting off the old joint in the upset, beveling the end for welding and machining a small flat to come against the shoulder of the Ferrule. The pipe upset is then bored out to make a shrink fit on the Ferrule. The flat must be square with the axis of the pipe but the level need not be accurate in form.

3. *Thread Accurately Aligned*

When the pipe is heated the Ferrule is inserted into the bore of the upset until it shoulders. As the contact faces of the joint, Ferrule and upset are square, the axis of the thread and of the pipe are in alignment. The Ferrule fits tightly in the bore of the joint and of the upset, holding them rigidly during tacking and welding.

4. *Solid, Strong Weld*

As the weld is located in the thick section of the upset, it is stronger than the body of the pipe and has ample strength to withstand torque and bending stresses. The spacing of the shoulders is wide enough to allow proper flow of the weld metal and deep penetration of the weld into the Ferrule. The result is a solid welded structure from inside to outside, and the inner surface of the joint is smooth when the Ferrule is bored out.

The service life of drill pipe can be greatly prolonged by entirely removing the old, worn joints and replacing them with new joints. All types of integral joint drill pipe can be equipped with new tool joints by the "Ferrule-Weld" method. With this new, fast, accurate method drill strings can be kept in service with the minimum of lost time and the maximum of efficiency due to true, tight tool joints.

Extends Useful Life of Pipe

Reconditioning drill pipe in conveniently located field shops save transportation costs and reduces the length of time pipe is out of service giving the operator the maximum safe use from each joint of pipe.

DRILLING PRACTICES UNDER PRESENT CONDITIONS

By **B. J. DOWD**, Union Producing Company

WORLD WAR No. 2 has caused great change in our national life, particularly in the petroleum industry. We are today meeting the greatest demand for petroleum products and at the same time are faced with great shortages of manpower, material and transportation facilities. These handicaps under which we operate are well known to most of you but little understood or appreciated by those outside the industry.

The contractor is a specialist in drilling wells and has played an important part in the development of the petroleum industry. Under normal conditions it was not possible for the small operator to obtain the skilled help or advisable to own the equipment when both men and equipment would be idle a large part of the time. Also, larger operators have varied development programs that make it advisable to contract all, or part, of their drilling. This situation is greatly magnified under present conditions as many operators, who formerly drilled their own wells have sold their rigs and are now contracting all drilling work. Therefore, the contractor, more today than ever before, is performing a real service to the industry. He has three obligations to the industry and his ability to carry out two of them is greatly affected by present conditions.

THE foremost — but seldom mentioned —of these obligations is the contractor's reputation for honest and fair dealings. It is difficult to anticipate the problems that may arise in the drilling of wells and to define the responsibility of each party in terms of a written contract. It is, therefore, important that each party has that confidence in the other that will enable him to make adjustments to the satisfaction of both.

The two obligations that are greatly affected by present conditions are the use of adequate equipment and the use of competent skilled workmen who will use such methods as will result in a safe, economical, and rapid completion of the well.

Smart contractors have always taken care of their equipment and under present conditions have redoubled their efforts in this respect. Rigs have always been painted when running and when stacked. When rigs are stacked the crankcases are filled with oil, fluid and steam ends are filled with oil and sealed to preserve the equipment; boilers are painted, the flues and fire boxes swabbed with oil, and the boilers are kept full of water up into a nipple connected to the steam outlet to prevent internal corrosion.

Drill pipes are being run longer and more care is being taken of drill pipe than was thought possible prior to the war. Drill pipe is being inspected internally by tuboscope and externally by micrometers. The bad joints are culled, the others repaired. When new tool joints are not available for replacement the old ones are being rebuilt. Various methods of applying tungsten carbide or other hard facing materials to tool joint boxes are being developed and these methods increase the life of the tool joints considerably. This metal is laid on in various ingenious ways in such manner as not to increase the outside diameter of the boxes nor to interfere with the operation of the elevators. When the drill pipe is not in use it is painted or oiled inside and outside.

Proper maintenance of equipment and observance of safe practices are of great importance —well-balanced drilling fluids should be used.

CONTRACTORS are diligently doing these things—trying to make their drill pipe last as long as possible, yet it has to be replaced some time. The new pipe that is available seems to be of inferior steel. Most of you keep several good joints of pipe immediately above the drill collars and change these joints around so as not to run the same joint in the same position too long. This is done to minimize breaks. Present day steels are supposed to be the equivalent of those formerly available. However, performance to date refutes this argument as many fishing jobs have occurred soon after new drill pipe was run on top of the drill collars.

The same is true with drill collars. All replacement drill collars and subs seem to be of an inferior steel as more drill collar trouble is encountered today than before the present emergency. Drill collars are heat-treated; they are magnofluxed repeatedly to find hidden fatigue cracks; joints are carefully made up and good compound used; collars and subs are rethreaded regularly. These are some of the precautions taken, yet fishing jobs continue when the present day inferior steels have to be used. To make matters worse, many of the fishing tools are of inferior steel and unknown or doubtful strength.

Top control equipment will not be effective unless the casing to which it is attached is in good condition. This is especially important today as some of the casing is made of inferior steel, steel far too soft in many cases. Another cause of casing wear is the inability to obtain delivery on drill-pipe protectors. Even when kellies, blocks, rotaries, etc., are carefully lined up, holes will be worn in the casing due to protectors not being full size and the casing being soft.

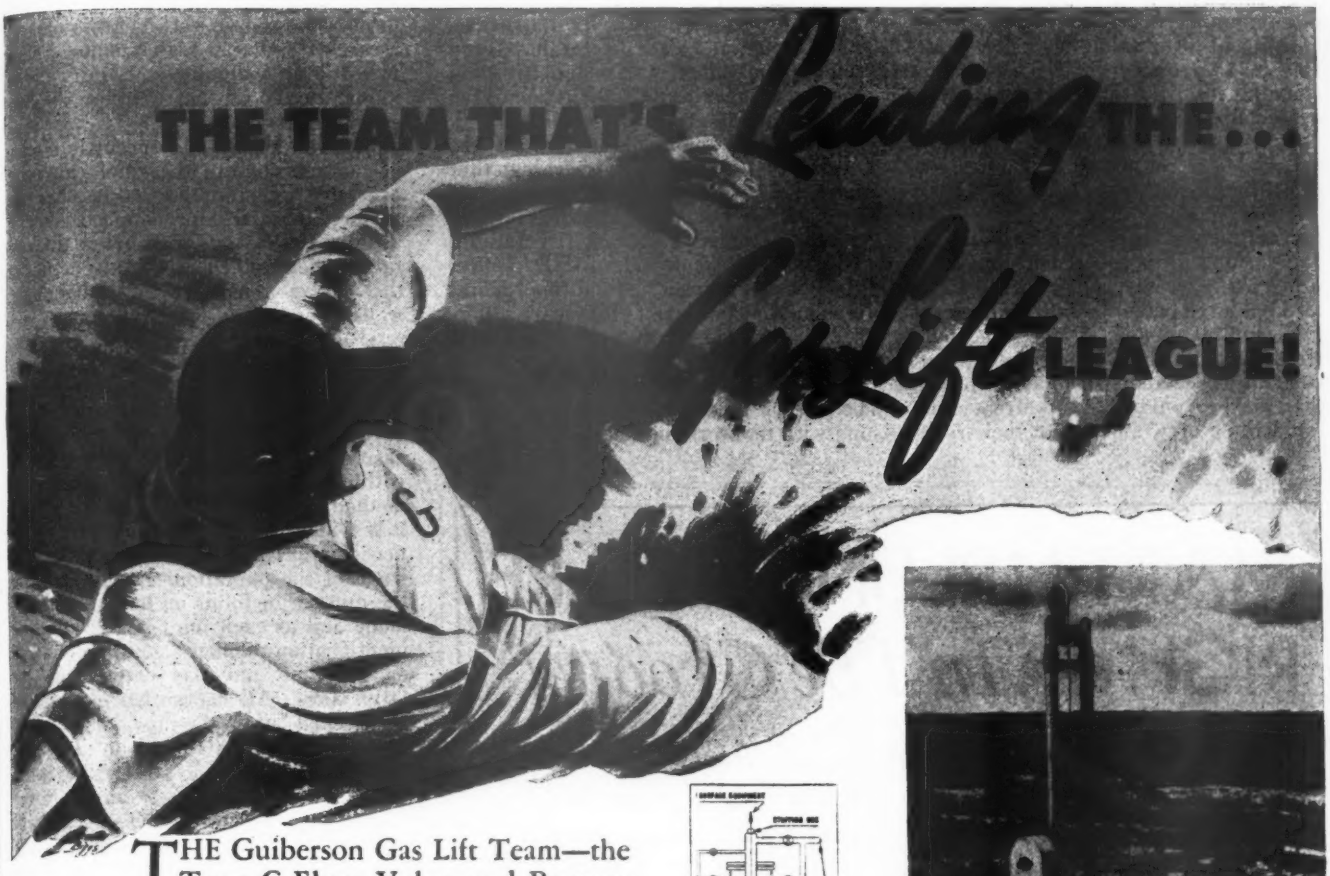
Drill-pipe tool joints, drill collars, and rock bits are critical major items and no drilling program can be accomplished without them. Drawworks can be patched up; various sizes and makes of pumps, rotaries, engines, etc., can be used but wells cannot be drilled efficiently without good drill pipe, tool joints, drill collars, and rock bits. Therefore, it can be truthfully said that the use of adequate equipment is greatly affected by present conditions.

The third obligation is that the contractor will use competent, skilled workmen who will use such methods as will result in a safe, economical, and rapid completion of the well. This has been rather difficult due to the manpower shortage but operators know that the contractors are doing the best they can under existing conditions. It is with the practices and methods that we are now concerned.

Perhaps the fear of a blowout is the greatest mutual concern. If this occurs the operator may lose part of his mineral reserve and the contractor certainly may lose the hole and possibly most of his rig. Perhaps the most important factor in the prevention of blowouts is the proper conditioning of the mud.

The history of mud treatment is interesting in that it clearly reminds us that the solution of one problem frequently indicates another to be solved. The first objective in mud treatment was to reduce viscosity in order to release occluded gas, remove cuttings, obtain sufficient hydrostatic head to prevent blowouts, and secure a more pumpable fluid. From continued study it became evident that filtration of water into the surrounding formation might be partly responsible for such troubles as stuck pipe, poor cement jobs, oversize holes, and heaving shale. The solution of such problems required the accumulation and study of much data by technical and research men. Some of the materials available to the industry for the conditioning of drilling mud are: Mud weighting materials, gel-forming colloidal drilling clay, salt-water resisting drilling clay, special clays used as suspending agents when high concentrations of salt or salt water are encountered, fibrous materials for restoring lost

*Presented at annual meeting of the American Association of Oilwell Drilling Contractors, Fort Worth, Texas, August 3 and 4, 1944.



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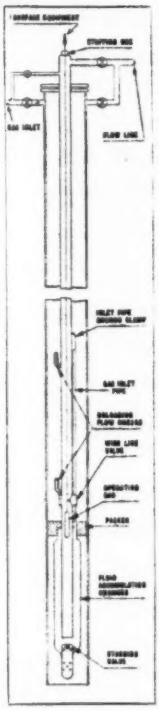

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circulation, chemicals for increasing viscosity and decreasing viscosity, materials for overcoming the effect of cement contamination in mud, materials for overcoming the effect of gypsum and anhydrite contamination in mud, and materials for controlling the water loss of drilling muds.

The proper use of these materials can prevent many blowouts, stuck drill pipe and ensuing fishing jobs, heaving shale, problems encountered when drilling through large bodies of salt, bad cement jobs, and many other problems encountered while drilling. The method of treatment has been reduced to such routine that average muds are now treated by the drilling crew along with their regular duties. To their tools, the centrifuge, hydrometer, and viscosimeter, have been added the filter press and titration papers, along with an explanation of the basic principles involved.

From the studies to determine the causes of wild wells, it is evident that improper drilling mud is one of the most pronounced. Other causes, which far outnumber the cases of material failure, are poor judgment, lack of skill in operating the equipment and improper maintenance of equipment. Recently, a person was confident that his equipment was in condition to work on a well, yet when it was suggested that the preventer be given a pressure test before proceeding with the work, he found it necessary to do some repair work. This is clearly a case of improper maintenance. Therefore, it is a good policy to require a crew to operate the preventer equipment once every 24 hr.

Crooked kellies and eccentric motion of the rotaries are the chief causes of excessive wear on the casing near the surface. The most pronounced wear is usually 100 ft. to 200 ft. below the surface as determined by the inspection of the casing removed from abandoned wells.

ACCURATE well measurements are very important for successful completions. It has been demonstrated that a difference of a few feet between drill pipe and casing measurements in deep holes is within reason. Without describing any method of measuring casing in detail, it is evident that certain precautions are necessary. To permit a check at any stage of the operation, an inventory of the number of joints on hand should be made and as each joint is measured an identification number should be chalked on the pipe and also entered on the tally sheet. All measurements should be checked before the pipe goes into the ground. Drill pipe should be measured in and out of the hole at regular intervals so that the correct depth of the hole is known at all times. This will insure cores being taken at the proper time and that the correct depth of known markers is recorded.

Much excellent study has been given to the problem of procuring satisfactory cement jobs in recent years, yet much remains to be done. Today, because of multiple completions, future workovers, thin sands, seclusion of salt water in upper sands and control of gas-oil ratios, each vertical foot must be effectively sealed. Caliper logging is a great help in determining the amount of cement required as it is now definitely known that the size of the hole is usually larger than the size of the bit used. This "washing out" of the formation and the thickness of the filter cake can be controlled to a certain extent by proper condition of the drilling mud.

Another factor that influences the use of the safe practices today is that of transportation. Time and again contractors have been forced to take chances or run some faulty equipment because trucks were not available to move the equipment needed.

Therefore, it can be truthfully said that the present emergency greatly affects the contractor in two ways:

1. His use of adequate material due to the inferior quality of steel being used in some equipment and shortage of other material.

2. His complete employment of safe practices due to shortage of skilled manpower, transportation facilities, and maintenance materials.

To you there is nothing new in this discussion. I sincerely trust that all of my remarks will be accepted in the spirit in which they are made — as a friendly and, I hope, constructive discussion of the current drilling problems confronting you. ★★★

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Write for Illustrated Catalog, or see Composite Catalog, Page 1551

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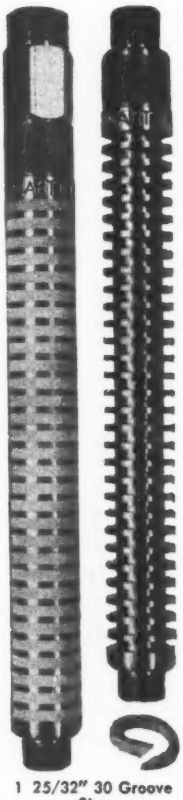

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THE RELATION OF AVIATION FUEL QUALITY TO ENGINE PERFORMANCE*

By **W. J. SWEENEY**, Standard Oil Development Company,
Associate Director Esso Laboratories

THE chief limiting factor in aviation fuel performance today is the familiar tendency of most petroleum hydrocarbons to knock under increased power conditions, thus to threaten destruction of the very engines they operate.

I will try to demonstrate, as simply as possible, how this one ceiling factor limits both the performance and the range of operation in an aircraft. In the course of this discussion of the phenomenon of knocking, I will point out why there is need for considerably more full-scale engine test data to guide our further improvement of fuel quality. The improvement may come through better knowledge of the anti-knock qualities of various individual hydrocarbons. This in itself is a complicated problem

Chief limiting factor in aviation fuel performance is the tendency of most petroleum hydrocarbons to knock under accelerated power.

because there are possibly millions of hydrocarbons present in petroleum. Alternately the improvement may come through better engine design to meet knock conditions. In many cases, the measure of this improvement must be made by closer reference to actual test data, obtained in representative aircraft engines.

To perform its function, the aircraft engine must produce the maximum amount of power, consume the lowest possible amount of fuel, and weigh as little as is consistent with the strength it must have to withstand the terrific stresses imposed upon it. Unfortunately, these things are to a considerable degree contradictory. For example, the power output of the engine when operating at its best economy (on the lowest weight of fuel) may be limited by knocking. To obtain maximum power, it is necessary to take steps to avoid this knocking. This is done by enrichening the mixture—feeding to the engine a larger proportion of fuel to air than it theoretically needs to produce that power.

*Presented at opening of Aviation Engine Fuel Test Unit, Bayway, New Jersey, September 19, 1944.

Knock—a bad actor. Before looking into the reasons why this is so, let us first see what knocking is. In Fig. 1 is shown a tube of fuel-air mixture, ignited at one end by a spark plug. The following sequence of events occur:

1. Ignition of the mixture by the spark plug.

2. Relatively slow burning of the mixture, progressing away from the spark plug.

3. Rapid increase in pressure and temperature of the unburned portion of the mixture ahead of the flame front until a condition is reached that makes that unburned mixture explode violently or detonate.

4. Pressure waves set up within cylinder, resulting in knock; rapid scrubbing of walls by vibrating gas, rise in temperature of walls, loss in engine power, and eventual destruction of parts.

If fuels did not vary in anti-knock quality or tendency to knock, they could all be evaluated reasonably by one characteristic—the number of heat units (B.t.u.) per lb.; however, knock is a very bad actor. It limits economy (range of operation) and it limits power (performance).

Modern aircraft fuels are miracles of high anti-knock quality. They have permitted engines to be built capable of developing power outputs undreamed of only a short time ago. This great team of engine and fuel powers our fighting aircraft today. Nevertheless, these engines must still employ rich, relatively uneconomical mixtures to develop maximum power for take-off, climb, and high speed in order to function on lean, economical mixtures during normal cruising operation. The reasons for this will be seen as we go along.

An aircraft engine is a device for converting heat energy into mechanical energy or useful work. Its working fluid is air, or, more accurately, nitrogen from air plus the products of combustion. These combustion products are the gases carbon dioxide, carbon monoxide, water vapor, and hydrogen, in varying proportions depending on the conditions of burning in the cylinders. It is a fact not generally appreciated, that the power output of a gasoline engine is more nearly proportional to the amount of air (or oxygen in the air) burned than to the amount of gasoline consumed. This should be kept in mind. It is the reason why aircraft engines are supercharged or "boosted" to increase manifold pressure for take-off and for operation at high altitudes.

Efficiency: Actual vs. theoretical. Let us look at a very much simplified calculation of the thermal efficiency of an actual engine, as compared with that of the theoretical engine—see Table 1.

The actual engine is naturally much less efficient than the theoretical engine,

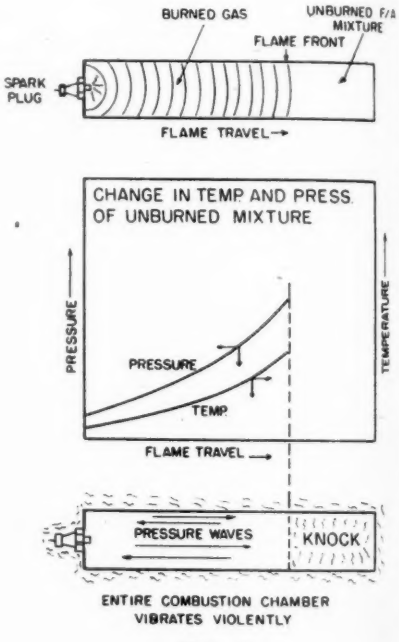

FIG. 1

since it has mechanically operated valves that require time to open and close, thus permitting dilution of the fuel charge with exhaust gases, and because the mixture will not burn instantaneously after ignition. Moreover, it is impossible in an actual engine to prevent heat loss from the gas to the walls and the temperatures that the metal parts of the engine can stand are limited so heat must be removed in order to keep temperatures of cylinders and pistons within safe limits. Heat likewise is removed by the lubricating oil. All this means fins for

TABLE 1
Actual vs. theoretical engine (7 to 1 compression ratio)

	Actual		Theoretical	
Total heat in fuel, B.t.u. per lb.		19,000		19,000
Heat lost to exhaust, B.t.u.	6,500		8,500	
Heat lost in cylinder cooling, B.t.u.	6,000		0	
Total heat lost, B.t.u.		12,500		8,500
Usable heat: available to produce work		6,500		10,500
Thermal efficiency $\left\{\frac{\text{Usable heat}}{\text{Total heat}}\right\}$	34%		55%	
Theoretical lb. of fuel per b. hp-hr. (no heat losses)	(0.134)		(0.134)	
Actual lb. of fuel per b. hp-hr. at stated efficiency	0.394		0.244	

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cooling cylinders and lubricating oil, which place an added drag on the airplane; special metals to withstand high temperatures, engine lubricants to function under these severe conditions, and many other problems that the designer, the metallurgist, and the oil refiner must solve.

Roughly speaking, the total heat in a pound of fuel is divided as shown in Table 1. This, however, applies only to operation with the theoretically correct ratio of fuel to air, typified in practice by cruising conditions at low power output. For high power output, as at take-off, an engine designed to give maximum fuel economy at cruising conditions must run with a rich mixture—a higher ratio of fuel to air — for otherwise it would knock, overheat, and quickly be destroyed.

▸ **Rich mixture reduces knock.** The following simple chemical equations show why rich mixtures produce less heat, hence less knock. They show the relative volumes of gases produced and the rela tive quantities of heat evolved when a given volume of oxygen in the air combines with or burns a hydrocarbon in lean mixture and in rich mixture respectively. (See Table 2.)

These equations show that, with rich mixtures, the heat evolved per pound of fuel or per pound of air is reduced. This produces less temperature rise in the cylinders, and less tendency to knock. This permits an increase in air supplied to the engine by means of added boost or supercharging, and added fuel, and this in turn permits greater power outputs before knocking again occurs.

Although all fuels will knock less in rich mixtures than at the theoretically correct fuel-air ratio, some are better than others in this respect.

▸ **Effect of mixture change on power and economy.** Table 3 shows what this means in terms of power output and fuel consumption in an aircraft engine of 2000 rated b. hp.:

Here we see that fuel consumption at cruise, the condition of best economy, is 0.40 lb. of fuel per b. hp-hr. For the increase of 600 hp. to bring the engine to rated continuous power, fuel consumption is at the rate of 0.82 lb. per b. hp-hr., and thermal efficiency is reduced to 16 per cent. Fuel consumption for the increase from rated 2000 to 2400 take-off hp. jumps to 1.38 lb. per b. hp-hr., and thermal efficiency for the same range drops to 10 per cent. Full power, rich-mixture operation is expensive.

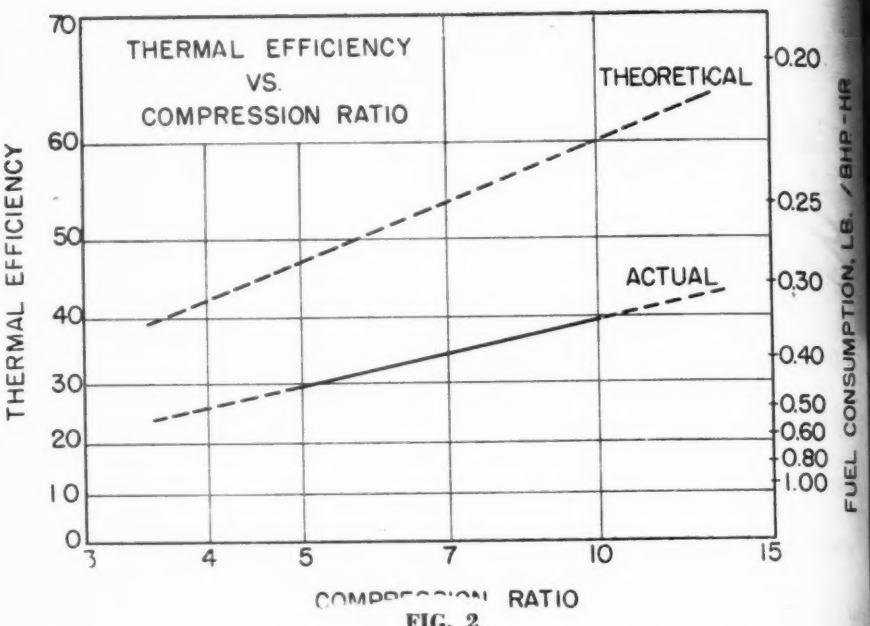

FIG. 2

▸ **Effect of fuel quality on economy and performance.** This indicates where improvements in fuel quality can, in the future, help reduce airplane operating costs or improve performance. There are a number of ways that these benefits might be effected:

1. Same cruise quality but better rich mixture quality, so that same power as at present can be obtained with less enrichment. Result: Better economy.

2. Same cruise quality but better rich mixture quality, so that greater power can be obtained with same enrichment as at present. Result: Better performance. (Such performance helped win the Battle of Britain.)

3. Better cruise quality and same rich mixture quality. Result: Greater range of operation. (This fuel may help win the Battle of the Pacific.)

4. Better cruise quality and better rich mixture quality. Result: Greater range and better performance. (Such a fuel would be an improvement over (3) and would be even more valuable in the Japanese conflict.)

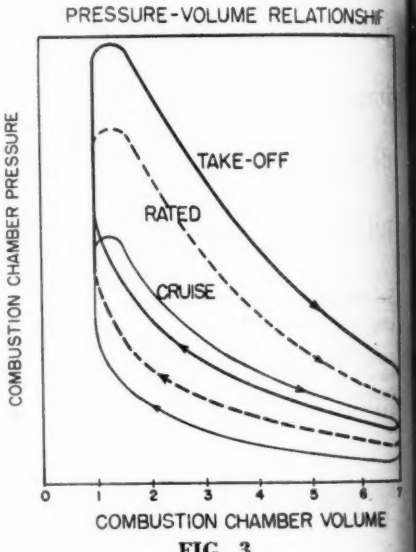

FIG. 3

TABLE 2

100% of theoretical fuel (cruise or maximum economy lean mixture—fuel-air ratio (0.067)

$$1\ CH_2 + 1.5\ O_2 \longrightarrow CO_2 + H_2O$$

Heat evolved = 19,000 B.t.u. per lb. fuel
or 1,270 B.t.u. per lb. air

150% of theoretical fuel (take-off or full power rich mixture—fuel-air ratio (0.10)

$$1.5\ CH_2 + 1.5\ O_2 \longrightarrow 0.53\ CO_2 + 0.97\ H_2O + 0.97\ CO + 0.53\ H_2$$

Heat evolved = 10,900 B.t.u. per lb. fuel
or 1,090 B.t.u. per lb. air

TABLE 3

	Cruise	Rated continuous	Take-off
Horsepower delivered	1,400	2,000	2,400
Lb. fuel consumed per hr.	560	1,050	1,600
Gal. fuel consumed per hr. (assuming 6 lb. per gal)	94	175	266
Fuel-air ratio	0.07	0.085	0.10
Total heat in fuel, B.t.u. (assuming 19,000 B.t.u. per lb.)	10,600,000	20,000,000	30,400,000
Heat to produce power, B.t.u.	3,600,000	5,100,000	6,100,000
Heat lost, B.t.u. (difference)	7,000,000	14,900,000	24,300,000
Fuel consumption rate, overall lb. per b. hp-hr.	0.40	0.525	0.67
Thermal efficiency, overall	34%	26%	20%

▸ **Knock and economy.** Fig. 2 shows how knock affects economy or range of operation of an aircraft. The higher the compression ratio, and accordingly the higher the temperature, the better will be the resulting economy for a given power output. Neglecting mechanical considerations, the tendency of a fuel to knock limits the compression ratio with which it can be used, and hence the economy or range that can be attained.

▸ **Knock and power.** Fig. 3 presents three schematic indicator cards showing the increased cylinder pressures, and hence greater powers that are obtainable without knocking when richer mixtures are used. (For simplicity the power increase that is gained in practice by increasing speed has been neglected.) Three work areas are shown: The shaded

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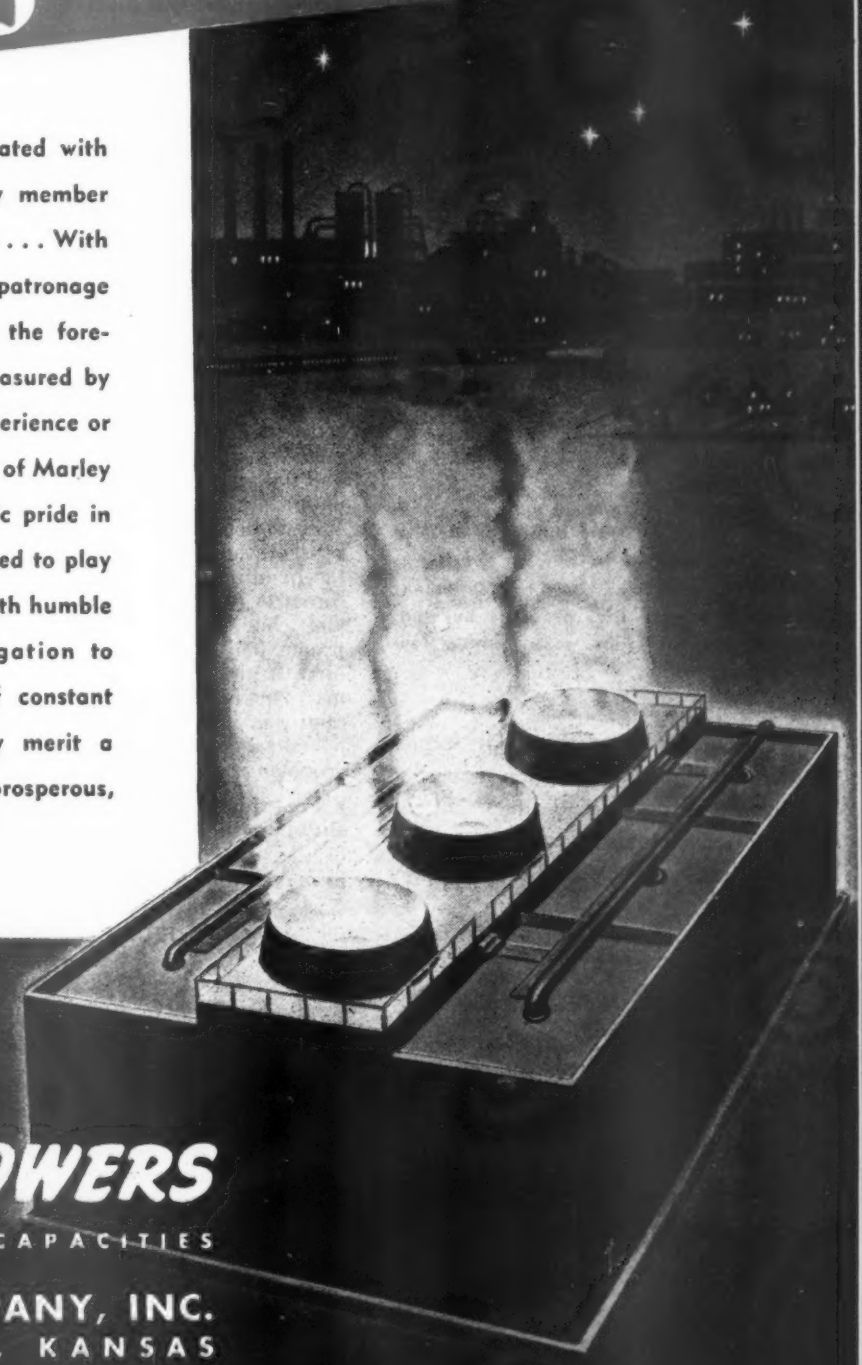

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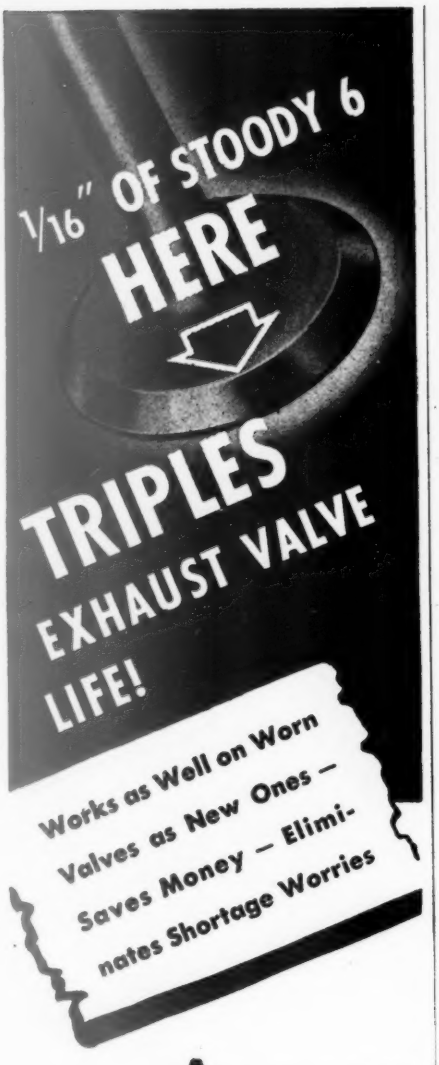
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TABLE 4
Comparison in anti-knock quality of pure hydrocarbons and prewar commercial fuels
(All with same lead content except where indicated)

Hydrocarbon	Lean mixture	Rich mixture	Difference
A	77	100	+23
B	70	93	+23
C	57	99	+42
D	54	76	+22
E	47	49	+ 2
100 octane (1938)	42	52	+10
F	42	46	+ 4
G	42	40	− 2
H	31	34	+ 3
91 octane (1938)	28	37	+ 9
I	21	19	− 2
J	21	15	− 6
K	14	14	0
73 octane (1938) (no lead)	2	9	+ 7

area is work (power developed) at cruise conditions; the area surrounded by the dotted line is work at rated continuous power conditions, and the unshaded area surrounded by the solid line is work at take-off conditions. These roughly represent the three conditions listed in Table 3. In each case the limit of permissible power is due to knock, but different fuels will show different rates of change in permissible power with rate of change in fuel-air ratio.

Automatic carburetor adjustments to meet operating conditions. The necessary adjustments to handle these changes in fuel-air ratio are complicated and to relieve the pilot the carburetor is designed to take care of them, automatically, as shown in Fig. 4. There are two settings, "automatic lean" and "automatic rich," determined by experience, and the pilot has the choice of either to obtain economy or power as required. With these settings the carburetor automatically supplies enough fuel based on the quantity of air passing through its throat to prevent knock under any normal condition when running on the proper fuel. In certain large long-range aircraft, however, the flight engineer may override the controls manually and approach incipient knock as closely as he dares in order to obtain maximum economy and hence greatest range.

Fuel quality variations under different operating conditions. A comparison of fuel quality on a lean-mixture performance and a rich-mixture performance basis is admittedly an over-simplification of the knock problem because other variables enter into the picture, such as compression ratio, spark advance, cylinder cooling, mixture temperature, speed, hot spots, etc. Nevertheless, the wide differences in fuel quality under different operating conditions can readily be shown by such a comparison.

There are millions of hydrocarbons possible and the number present in petroleum is probably in the hundreds of thousands. In the gasoline boiling range alone the number possible is around 5000. Of these, however, only a few dozen are known to be of superior anti-knock quality. Table 4 gives a comparison of relative knock quality of some of these hydrocarbons with prewar commercial fuels (the completely arbitrary scale used is not to be confused with octane number).

These ratings are not true quality measurements, but do serve to indicate the wide variations in fuel performance that can be obtained by varying engine

FIG. 4
TYPICAL MIXTURE CURVES

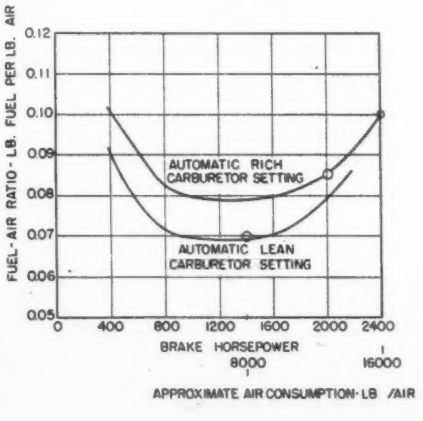
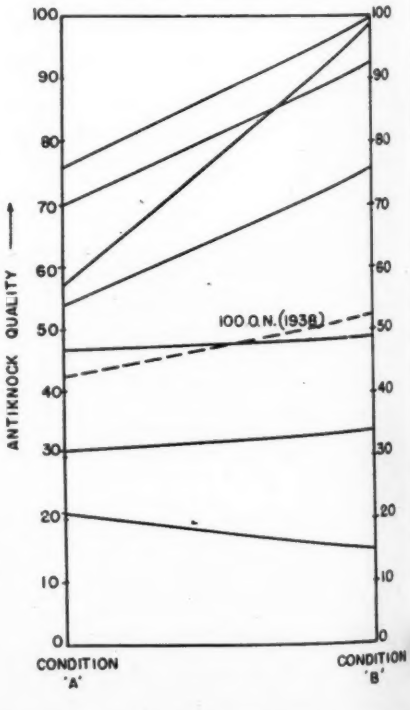
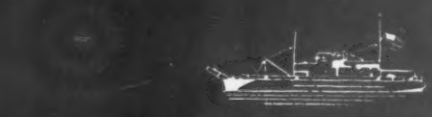
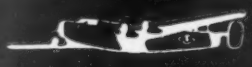
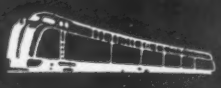


FIG. 5
PURE COMPOUNDS









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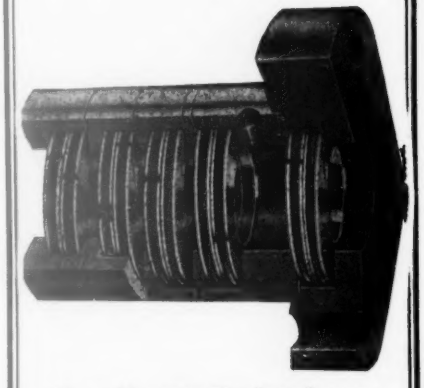

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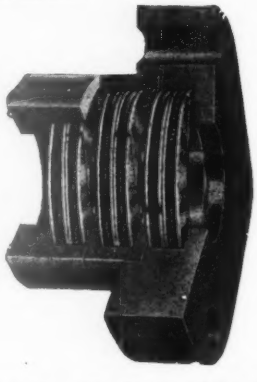

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operating conditions. The great differences in the lean mixture and rich mixture ratings of some of these fuels show that it is extremely important that the tests used to evaluate the fuels determine their quality in actual flight.

Fig. 5 shows graphically the data in Table 4. Two things are of particular interest:

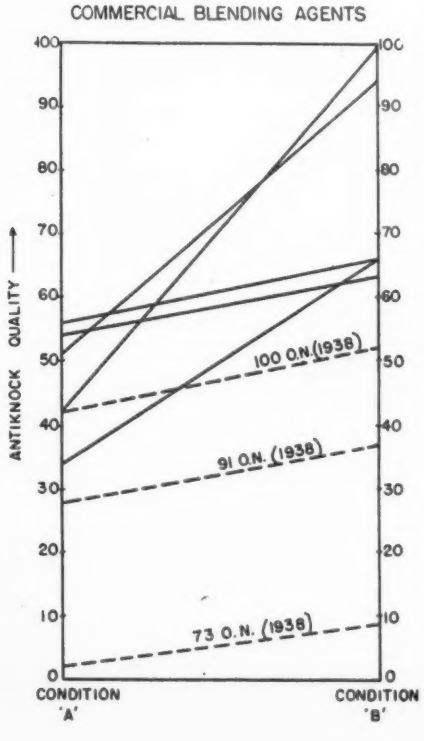
1. Existence of hydrocarbons that, with both lean and rich mixtures, exceed old style 100 octane gasoline in anti-knock quality.
2. The extremely great rate of change in anti-knock quality, in many cases, between lean mixture and rich mixture. Should the latter more nearly represent average flight performance than the former, the actual relative performance would in some cases be the opposite from that derived from data based on lean mixture ratings.

Fig. 6 shows a similar quality relation between old commercial fuels and a few presently available commercial blending agents. The same two points are seen.

Assuming that between the two extremes lie the actual knocking conditions experienced in flight, it is obviously important to know just where incipient knock is reached under different flight conditions and in different engines.

▸ **Evaluating fuel quality.** To redesign engines and aircraft to take full advantage of fuel improvements is no easy task. One phase of the job is to prove by adequate full-scale engine tests that the fuel has the added quality, how much and under what conditions of operation. Another is to determine what changes in superchargers, carburetors, ignition systems, coolers, etc., must be made to get the most from the new fuel-new engine combination. The fuel and the engine

FIG. 6



Move plant

Another gas cycling plant for the Carthage area of Panola County, East Texas field, was announced by Lone Star Gas Company and Rogers Lacy of Longview. They are moving a plant from Willow Springs area, Gregg County, to Carthage field. The Carthage reserve has been called second only to the Panhandle field in Texas as a gas reserve. It has a daily production of approximately 200,000,000 cu. ft. of high content gas.

are, in a sense, like the hen and the egg—which comes first?

The engine manufacturer cannot build his engine in production quantities until the fuel it needs is commercially available. The refiner cannot build the equipment for making the fuel without knowing what its composition must be to meet the needs of the engine. The fuel designer in his laboratories must arrive at this composition on the basis of practical tests. To meet this need—the very foundation of fuel and engine improvement—Standard Oil Development Company has built a full-scale multicylinder engine test stand.

▸ **Importance of new multicylinder test stand.** It is quite impossible to do all fuel test work on engines in flight, for several good reasons. For example, flight conditions of air temperature to carburetor and air temperature to cooling fins cannot be reproduced from day to day. Also, it is desirable in rating fuels to approach knocking conditions, thereby occasionally developing true knock, a most dangerous condition in flight. Although a good bit of flight data are absolutely necessary, it is generally desirable to obtain the background data on full-scale laboratory engines and then to check special points by flight tests. It is for such evaluations of presently available commercial blending agents and of promising experimental products that the new full-scale test stand has been built.

By present standards, petroleum as found in nature provides very poor aviation fuels. Broken down and synthesized, however, it gives exceedingly good fuels. As it will be produced in the future, petroleum gives promise of even greater improvements in anti-knock quality. Even now—in the midst of war—much can be done to improve fuel quality by selection of available products and modification of existing plants. Such improvements are the immediate aim of all of us operating the test stand, so that no matter how long the war, the armed forces will have available the best possible fuels compatible with the huge amounts required. ★ ★ ★

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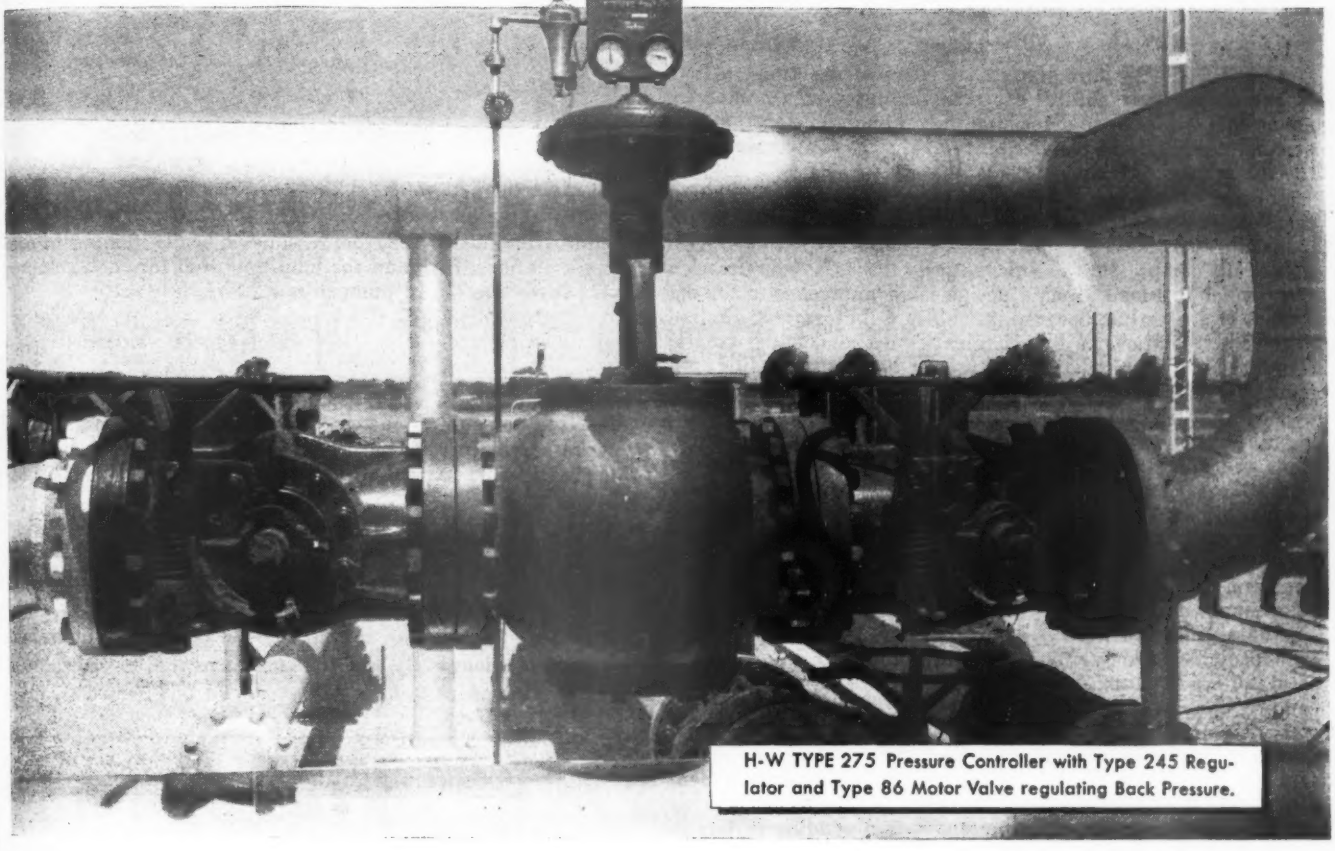

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By **C. L. BROCKSCHMIDT** and **M. K. HAGER**
Natural Gas Division, Office of War Utilities, WPB

EXCLUSIVE THE USUAL METHOD of designing a long natural gas pipe line involves a number of cut-and-try solutions to determine the optimum design that will produce the required deliverability at the market terminus for the minimum cost.

In long pipe lines of recent design, the distances between compressor stations have been graduated to compensate for the compressor fuel consumed en route and to permit the operation of all compressors at substantially the same compression ratio under full load. Such a design is advantageous to the operation of a pipe line because it enables a uniform distribution of the work load over all mechanical equipment, but it greatly complicates the calculations necessary to determine the optimum design.

Several attempts have been made to derive equations including all physical and economic factors influencing capital investment and operating cost of a pipe line. These equations have been differentiated and the differentials equated to zero to find the conditions of minimum cost or optimum design. Although such equations have been useful for setting limits and delineating trends, they are usually based on too many broad assumptions and generalities to provide an accurate, practical solution of optimum design. A common defect is that the optimum design obtained by such methods is often found to require pipe of an odd diameter not commercially available. To avoid complication of the equation, it is also necessary to assume a constant compression ratio and, in at least two instances, the optimum compression ratio was determined to be 1.33 and 1.35 for all pipe lines regardless of capacity, length, diameter, and station spacing. The mathematical argument developed in the appendices leads to the conclusion that the optimum compression ratio is not the same under different design conditions. Graph V illustrates that as the number of stations and the total compressor horsepower on a pipe line increase, the optimum compression ratio decreases, but remains greater than 1.4 for most practicable conditions of design. Most long pipe lines are currently operated at compression ratios above 1.5 under full load.

The optimum design for any pipe line of given length, diameter, and wall thickness is that which produces the required deliverability at the market terminus with a minimum of compressor horsepower. An optimum design must also determine the ideal distribution of compressor capacity, that is, the number of stations and the compression ratio necessary to achieve maximum compressor utility.

To facilitate the mathematical steps necessary for developing equations expressing the various physical factors involved in a pipe line design, it is convenient to adopt the system of notation described in Appendix I. The general flow equation is simplified in Appendix II to a form adaptable for later application in the derivations that follow. In Appendix III equations for total compressor horsepower and fuel requirements are derived. Equations for determining the graduated spacing of stations to compensate for compressor fuel and produce the same compression ratio at all stations under full load are derived in Appendix IV. In Appendix V all of the physical factors influencing a pipe line design are combined in the expression,

$$\frac{L_t^{0.54}\, Q_1}{t^{1.08}\, d^{1.535}} = 143.5\left(\frac{r^2-1}{r^2}\right)^{0.54} \times \left[\frac{1-(1+ab)^{1.85n}}{[1-(1+ab)^{1.85}]\ (1+ab)^{1.85(n-1)}}\right]^{0.54}$$

which can be written in terms of significant factors as follows:

$$\frac{f_L \times Q_1}{f_P} = f_S$$

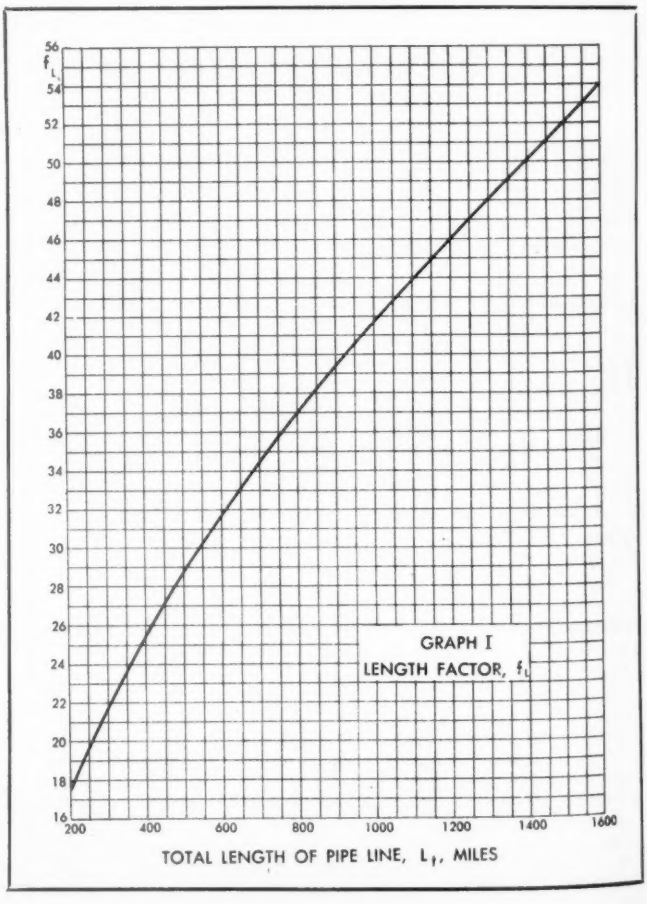
where the length factor (f_L) is a simple function of the total length of the pipe line; the pipe factor (f_P) is a function of both diameter and wall thickness of the pipe; Q_1 is the deliverability at the market terminus, and the station factor (f_S) is a complex function of the compression ratio, the number of compressor stations, fuel, and the b.hp. required for each compression per million cu. ft. pumped per 24 hr.

$H_t = Q_1\left[\frac{(1+ab)^{n-1}-1}{a}\right]$ which can be written:

$H_t = Q_1 \times f_H$

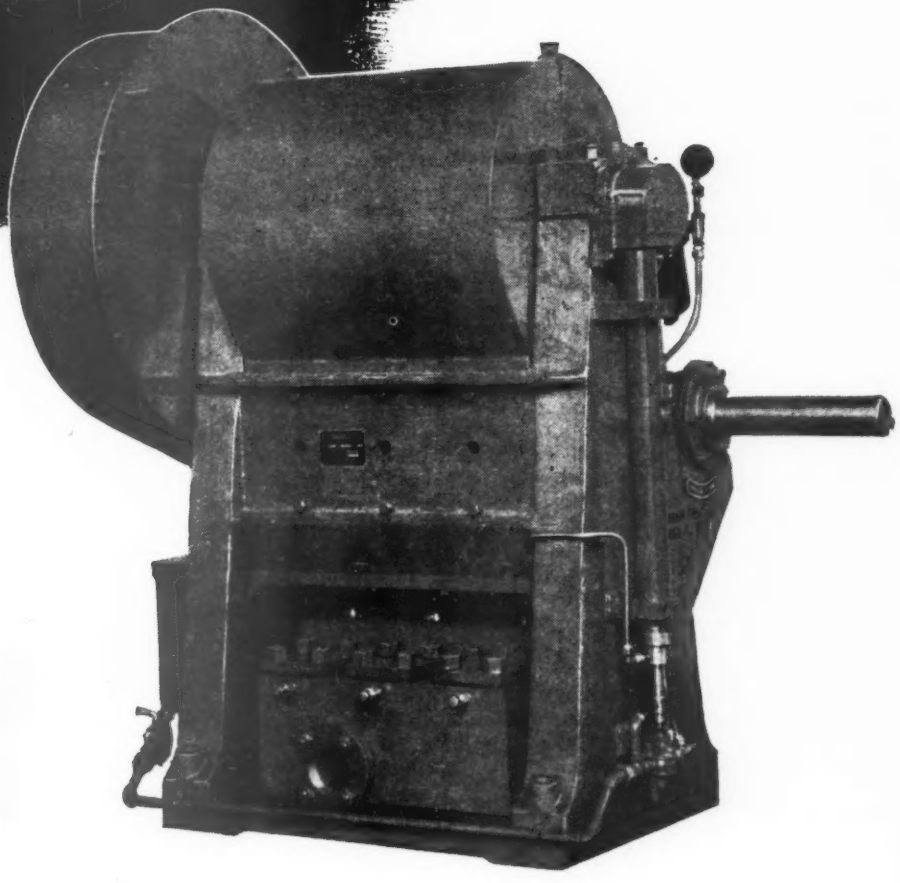
where the horsepower factor (f_H) may be defined as the total compressor b.hp. required in all stations except the field station per million cu. ft. delivered per 24 hr. at the market terminus.

When values of f_S and f_H are both plotted on the same graph against compression ratio and the number of stations as on Graph III, the operation of finding values of f_H correlated to a value of f_S is greatly facilitated. There are usually several values of f_H correlated to a given value of f_S. The optimum solution of a problem is the one that produces the lowest value of f_H. Minimum values of f_H vs. f_S can be taken directly from



for the severe conditions of ....

Water Flood Service



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Graph VII but these must be referred back to Graph III for interpretation with reference to compression ratio and the number of stations required.

The above factors will solve problems where the deliverability of a pipe line is given and the minimum compressor horsepower and ideal distribution of that horsepower is sought to achieve the required deliverability. Occasionally, the total horsepower is given and it is required to find the maximum deliverability that horsepower will produce. The f_s factor is useless for such a solution and a mathematical operative, f_{SH}, must be employed.

$$f_{SH} = f_s \times f_H = \frac{f_L \times H_t}{f_P}$$

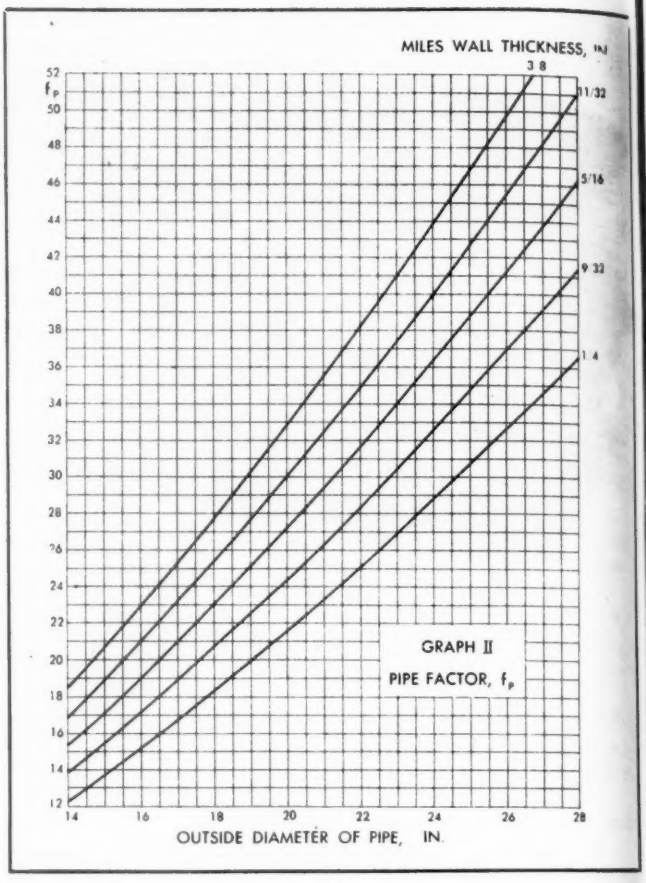
Values of f_{SH} are correlated with f_H on Graph IV against compression ratio and the number of stations. Minimum, or optimum, values of f_H are plotted against f_{SH} on Graph VII.

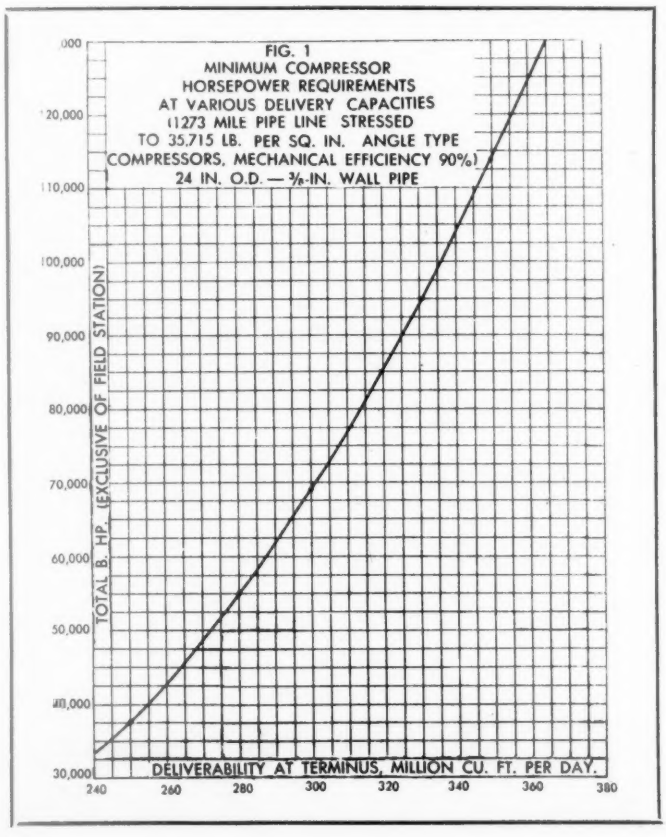
All graphs accompanying the appendices are for gas of 0.607 specific gravity, angle type compressors of 90 per cent mechanical efficiency, and an allowable working stress of 35,715 lb. per sq. in., which allows a 1.4 design factor of safety for Grade B material. If conditions involving other specific gravities, working stresses, or horizontal compressors of higher efficiency are encountered, suitable correction factors must be applied to the f_s, f_H, and f_{SH} factors as shown in Appendix V.

Examples 1 and 2 illustrate the solution of a typical pipe line problem by the use of the graphs and significant factors. It can be seen that there is always more than one solution of any given problem, the optimum solution being the one that delivers the most gas to market for the least compressor horsepower. The computations shown could have been shortened by referring directly to Graph VII for the minimum value of f_H.

The five optimum solutions in Examples 1 and 2 are points on the curve reproduced in Fig. 1, which plots minimum compressor horsepower required at various delivery capacities for the given pipe line. It is but a short step to apply economic data and determine the point on the curve where the minimum cost per unit volume of gas delivered at the market terminus is obtained.

The design of a new pipe line consists of delineating a similar curve and marking the point of minimum cost for each diameter and weight of pipe under consideration. This suggested method resolves a pipe line design into two phases, the physical and the economic, each of which is solved independently. The very nature of the data affirms the desirability of such a procedure. On the one hand the operator is concerned with the strength of steel pipe, the thermodynamics of compressors, the daily deliverability of the pipe line. On the other hand, he is concerned only with the cost of steel pipe and the labor of laying it in a variable terrain, the cost of compressors and installations, annual fixed capital and operating expenses, the cost of gas in the field, and the annual delivery of gas at various assumed load factors. Such factors are so incompatible that it may be a mistake to over-simplify the argument by combining them all in one equation.





It is well to weigh all factors surrounding each possible diameter and weight of pipe individually before selecting a size for the final detailed design. The task can be accomplished in a matter of hours by the above method whereas weeks might be required to compute the data by direct methods. If the design is to be based on conditions different from those assumed in the appendices, it is suggested that a new set of Graphs III to VII be constructed on the corrected values of the factors. It should be remembered that throughout this study the field station and the market terminal station, if any, are not taken into account in calculating compressor horsepower requirements, for these stations are usually special problems influenced by factors foreign to the main line.

Example No. 1

Given: 1273 miles of 24-in. O.D. by 3/8-in. wall pipe line stressed to 35,715 lb. per sq. in.

To find: the total compressor b.hp. required (exclusive of field station) to produce a deliverability of (a) 250,000,000 cu. ft., (b) 300,000,000 cu. ft., and (c) 350,000,000 cu. ft. per day at the market terminus, assuming that the interval between stations is graduated so that all compressors operate at the same compression ratio at full load, and no deliveries are made en route except for compressor fuel.

Solution (a) $Q_1 = 250{,}000{,}000$ cu. ft. per day

From Graph I, $f_L = 47.50$

From Graph II, $f_P = 43.75$

$$f_s = \frac{f_L Q_1}{f_P} = \frac{47.50 \times 250}{43.75} = 271.6$$

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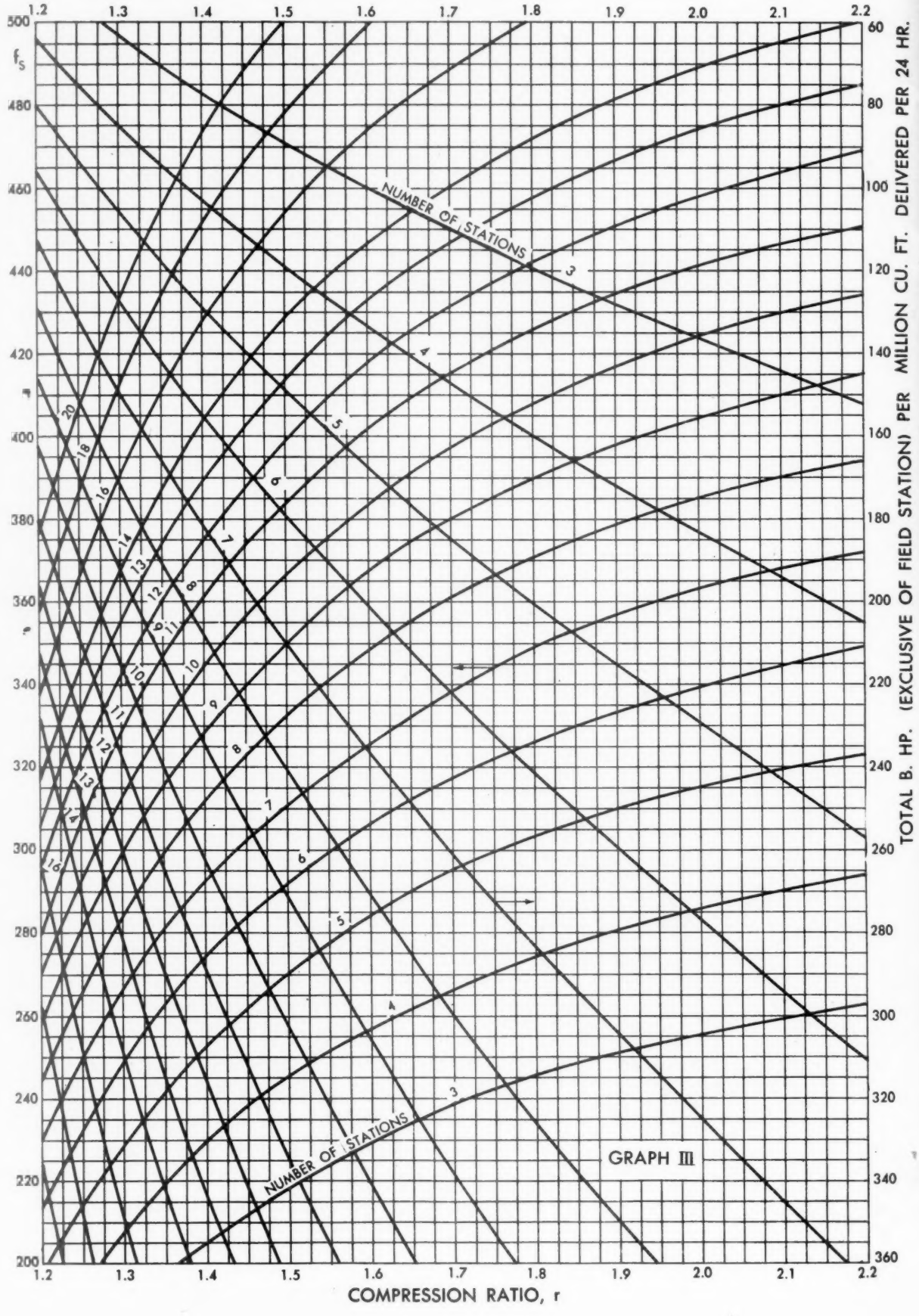
1.2
1.3
1.4
1.5
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500
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f_s
NUMBER OF STATIONS
3
4
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6
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8
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14
16
18
20
60
80
100
120
140
160
180
200
220
240
260
280
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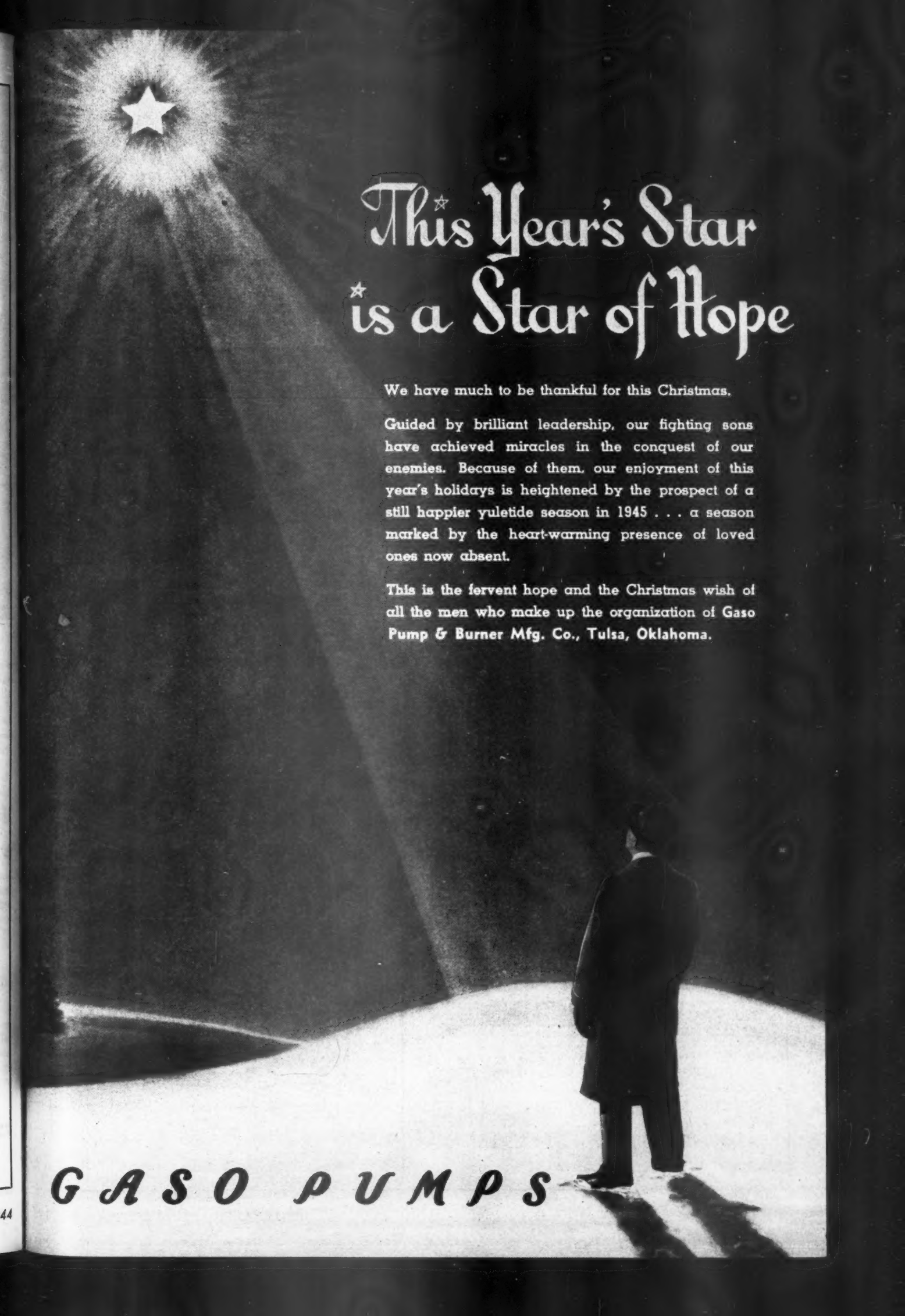
320
340
360
TOTAL B. HP. (EXCLUSIVE OF FIELD STATION) PER MILLION CU. FT. DELIVERED PER 24 HR.
GRAPH III
COMPRESSION RATIO, r


This Year's Star
is a Star of Hope
We have much to be thankful for this Christmas.
Guided by brilliant leadership, our fighting sons have achieved miracles in the conquest of our enemies. Because of them, our enjoyment of this year's holidays is heightened by the prospect of a still happier yuletide season in 1945 . . . a season marked by the heart-warming presence of loved ones now absent.
This is the fervent hope and the Christmas wish of all the men who make up the organization of Gaso Pump & Burner Mfg. Co., Tulsa, Oklahoma.
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FROM GRAPH III

f_s	No. of stations	Ratio	f_H	$H_t = 250 \times f_H$
271.6	4	1.765	155	38,780
271.6	5	1.510	150*	37,500*
271.6	6	1.390	152.5	38,100
271.6	7	1.316	155.5	38,900
271.6	8	1.265	157	39,280
271.6	9	1.228	160	40,000

Solution (b) $Q_1 = 300{,}000{,}000$ cu. ft. per day

$$f_s = \frac{47.50 \times 300}{43.75} = 325.8$$

f_s	No. of stations	Ratio	f_H	$H_t = 300 \times f_H$
325.8	6	1.800	242	72,600
325.8	7	1.600	236	70,800
325.8	8	1.468	231	69,300
325.8	9	1.390	230*	69,000*
325.8	10	1.335	232	69,600
325.8	11	1.290	232	69,600
325.8	12	1.260	236	70,800

Solution (c) $Q_1 = 350{,}000{,}000$ cu. ft. per day

$$f_s = \frac{47.50 \times 350}{43.75} = 380$$

f_s	No. of stations	Ratio	f_H	$H_t = 350 \times f_H$
380	8	1.920	354	124,000
380	9	1.700	339	118,800
380	10	1.575	331.5	116,000
380	11	1.485	329	115,100
380	12	1.420	326	114,200
380	13	1.368	325*	113,800*
380	14	1.332	329	115,000
380	16	1.277	332	116,200

*The optimum solution showing the disposition of the minimum total b.hp. required to produce the given flow.

Example No. 2

Given: the same pipe line described in example No. 1.

To find: the maximum deliverability at the market terminus that can be obtained with (a) 55,000 and (b) 95,000 compressor b.hp. installed in main line stations (excluding the field station), assuming that the interval between stations is graduated so that all compressors operate at the same compression ratio at full load, and no deliveries are made en route except for compressor fuel.

Solution (a) $H_t = 55{,}000$ b. hp.

$$f_{sH} = \frac{f_L H_t}{f_P} = \frac{47.50 \times 55{,}000}{43.75} = 59{,}730$$

FROM GRAPH IV

f_{sH}	No. of stations	Ratio	f_H	$Q_1 = 55{,}000 \div f_H$
59,730	5	1.790	199	276.3
59,730	6	1.580	196.5*	280.0*
59,730	7	1.455	197.5	278.5
59,730	8	1.370	197.5	278.5
59,730	9	1.310	197.5	278.5
59,730	10	1.267	200	275.0
59,730	12	1.207	200	275.0

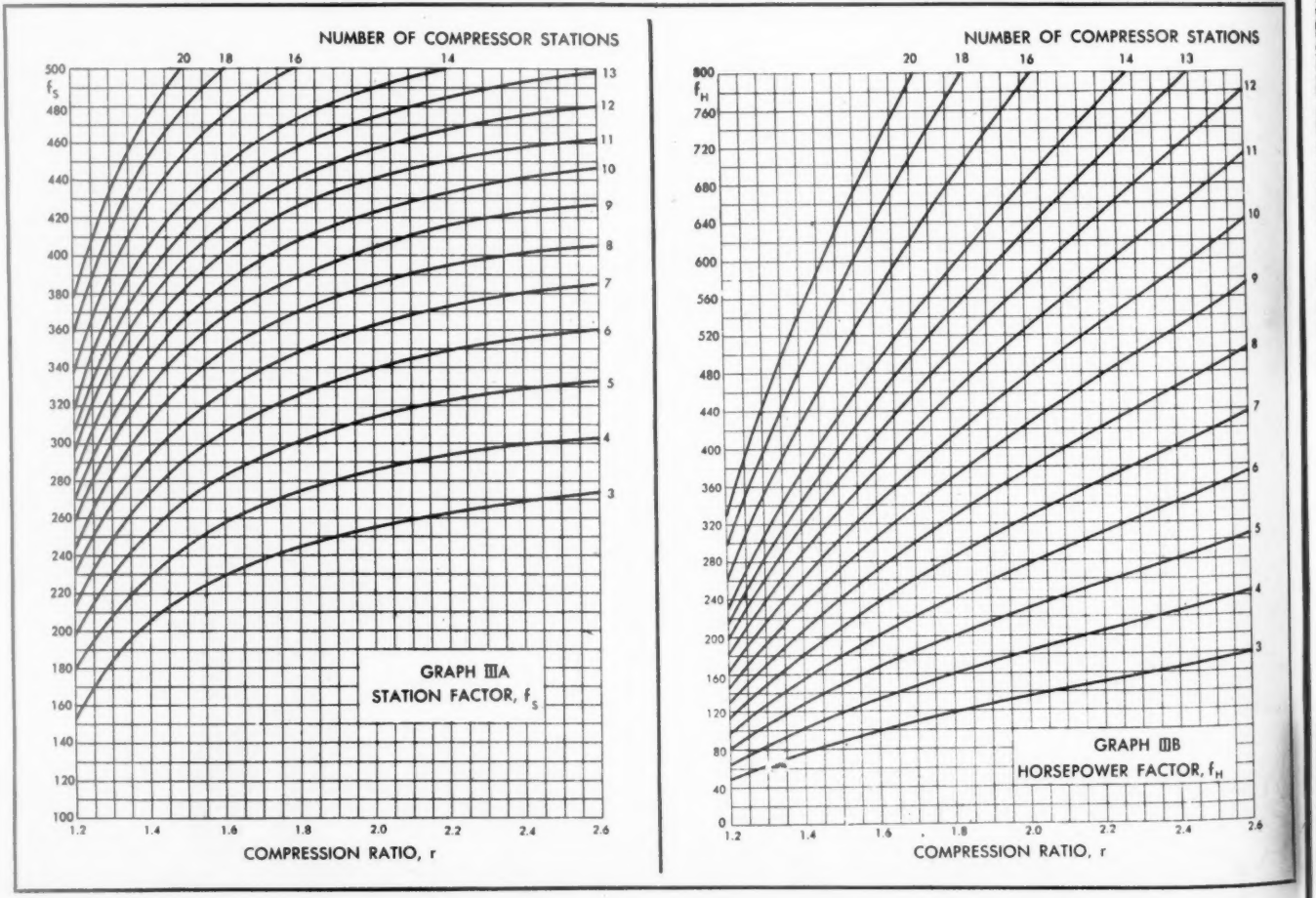
Solution (b) $H_t = 95{,}000$ b.hp.

$$f_{sH} = \frac{47.50 \times 95{,}000}{43.75} = 103{,}100$$

f_{sH}	No. of stations	Ratio	f_H	$Q_1 = 95{,}000 \div f_H$
103,100	6	2.125	298.5	318.2
103,100	7	1.840	292.5	324.8
103,100	8	1.668	289.5	328.1
103,100	9	1.546	287.0*	331.0*
103,100	10	1.462	287.0*	331.0*
103.100	11	1.396	287.0*	331.0*
103,100	12	1.347	287.0*	331.0*
103,100	14	1.272	288.0	330.0
103,100	16	1.230	290.0	327.6

*Optimum solutions.

The optimum solutions in examples 1 and 2 are combined and plotted in Fig. 1, Minimum Compressor Horsepower Required vs. Deliverability at the Market Terminus.



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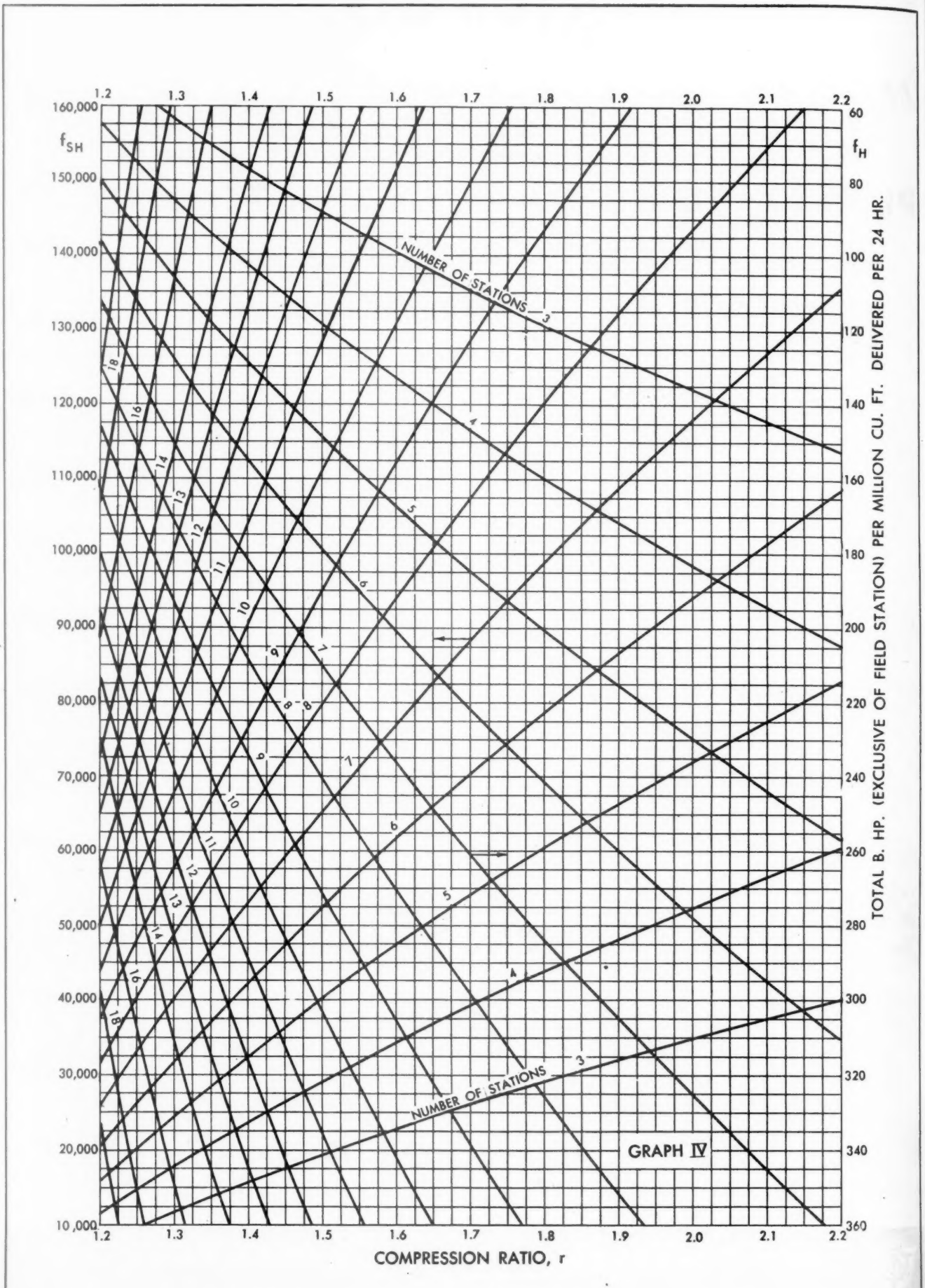

f_{SH}
f_H
TOTAL B. HP. (EXCLUSIVE OF FIELD STATION) PER MILLION CU. FT. DELIVERED PER 24 HR.
COMPRESSION RATIO, r
NUMBER OF STATIONS — 3
NUMBER OF STATIONS — 3
GRAPH IV
1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2
160,000 150,000 140,000 130,000 120,000 110,000 100,000 90,000 80,000 70,000 60,000 50,000 40,000 30,000 20,000 10,000
60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360

APPENDIX I

Notation

Symbol — *Definition and units*

A. Cross-sectional area of pipe, sq. ft.
a. Fuel gas consumed per hp., per 24 hr., million cu. ft. at P_o and T_o.
b. Compressor hp. required per million cu. ft. pumped per 24 hr.
D. Inside diameter of pipe, ft.
d. Inside diameter of pipe, in.
E. Pipe line experience factor, a decimal fraction expressing the ratio of the flow obtainable in actual practice to the theoretical flow in smooth pipe according to Nikuradse.
f. Coefficient of friction in the general flow formula, no units.
f_L. Length factor used in pipe line solutions, Appendix V.
f_p. Pipe factor used in pipe line solutions, Appendix V.
f_s. Station factor used in pipe line solutions, Appendix V.
f_H. Horsepower factor used in pipe line solutions, Appendix V.
$f_{SH} = f_S \times f_H$. A mathematical operative, Appendix V.
$F_1, F_2 \ldots F_{n-1}$. Fuel gas consumed at stations 1, 2 . . . n per 24 hr., million cu. ft.
$F_t = F_1 + F_2 \ldots + F_{n-1}$. Total fuel gas consumed in all stations (except the field station) per 24 hr., million cu. ft.
ϕ. Design factor of safety.
G. Specific gravity of gas, referred to air.
$H_1, H_2 \ldots H_{n-1}$. Compressor hp. at stations 1, 2 . . . (n — 1).
$H_t = H_1 + H_2 \ldots + H_{n-1}$. Total compressor hp. in all stations (except the field station).
k, k_1. Constant in the general flow equation.
K. Constant used in Appendix IV.
L. Length of pipe line (between stations), miles.
$L_1, L_2 \ldots L_n$. Lengths of pipe line sections 1, 2 . . . n, miles.
$L_t = L_1 + L_2 \ldots + L_n$. Total length of pipe line, miles.
n. Number of pipe line sections (between stations).
n—1. Number of compressor stations (excluding the field stations).
P_o. Pressure base, lb. per sq. in. abs.
P_1. Inlet (or station discharge) pressure, lb. per sq. in. abs.
P_2. Outlet (or station suction) pressure, lb. per sq. in. abs.
Q. Volume flowing per 24 hr., cu. ft. at P_o and T_o.
$Q_1, Q_2 \ldots Q_n$. Volume flowing in pipe line sections 1, 2 . . . n per 24 hr., million cu. ft. at P_o and T_o.
$r = P_1 \div P_2$. Compression ratio.
R_e. Reynold's Number, no units.
S. Density of gas, lb. per cu. ft. at P_o and T_o.
s. Ultimate fiber stress of pipe, lb. per sq. in.
t. Thickness of pipe wall, in.
T_o. Temperature base, °F. abs.
T_f. Flowing temperature of gas, °F. abs.
U. Velocity of flowing gas, ft. per sec.
Z. Absolute viscosity of gas, lb. per sec. per ft.
c_p. Specific heat at constant pressure.
C_v. Specific heat at constant volume.
C_G. Correction factor for specific gravity of gas, Appendix V.
C_E. Correction factor for mechanical efficiency of compressors.
C_s. Correction factor for working stress of pipe.

APPENDIX II

Pipe line flow equation

General equation for gas pipe line flow (U. S. Bureau of Mines Monograph 6):

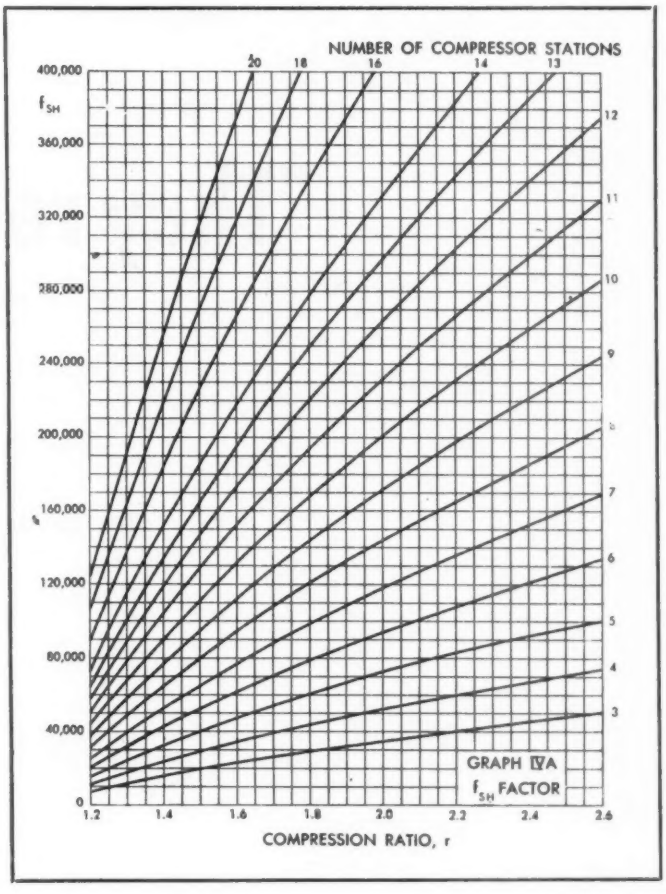
$$Q = 38.77 \frac{T_o}{P_o}\left[\frac{(P_1^2 - P_2^2)\ d^5}{G T_f L f}\right]^{\frac{1}{2}} \quad (1)$$

Reynolds Number:

$$R_e = \frac{DUS}{Z} \quad (2)$$

where:

$$D = \frac{d}{12}$$



$$U = \frac{144\,Q}{86{,}400 \times 0.7854\ d^2}$$

$$S = 0.0766\ G$$

$$Z = \frac{7}{10^6}$$

$$R_e = \frac{d \times Q \times 144 \times 0.0766 \times G \times 10^6}{12 \times 86{,}400 \times 0.7854 \times d^2 \times 7} = 1.935 \frac{QG}{d}. \quad (3)$$

Nikuradse's coefficient of friction for smooth pipe:

$$f = 0.0008 + 0.0552\ R_e^{-0.237}$$

which may be expressed in regions of turbulent flow when R is greater than 5,000,000 and less than 14,000,000 as follows:

$$\frac{1}{f} = 52\left(\frac{QG}{d}\right)^{0.1461}. \quad (4)$$

Substituting the above value of 1/f in equation (1):

$$Q = 38.77 \frac{T_o}{P_o}\left[\frac{(P_1^2 - P_2^2)\ d^5}{G T_f L}\right]^{\frac{1}{2}}\left[52\left(\frac{QG}{d}\right)^{0.1461}\right]^{\frac{1}{2}}$$

$$= 435.87\left(\frac{T_o}{P_o}\right)^{1.0788} d^{2.6182}\left[\frac{(P_1^2 - P_2^2)}{G^{0.8539}\ T_f\ L}\right]^{0.8394} \quad (5)$$

Equation (5) expresses the theoretical flow in smooth pipe according to Nikuradse's friction factor. An experience factor, E, may be introduced into the equation to represent the ratio of the known flow obtainable in commercial pipe lines to the theoretical flow in smooth pipe. Some operators refer to this factor as a pipe line "efficiency" factor. One major pipe line company has experienced values of E ranging from 0.925 to 0.95, the latter value representing the efficiency of a new line or a clean line just after a scraper has been passed through.

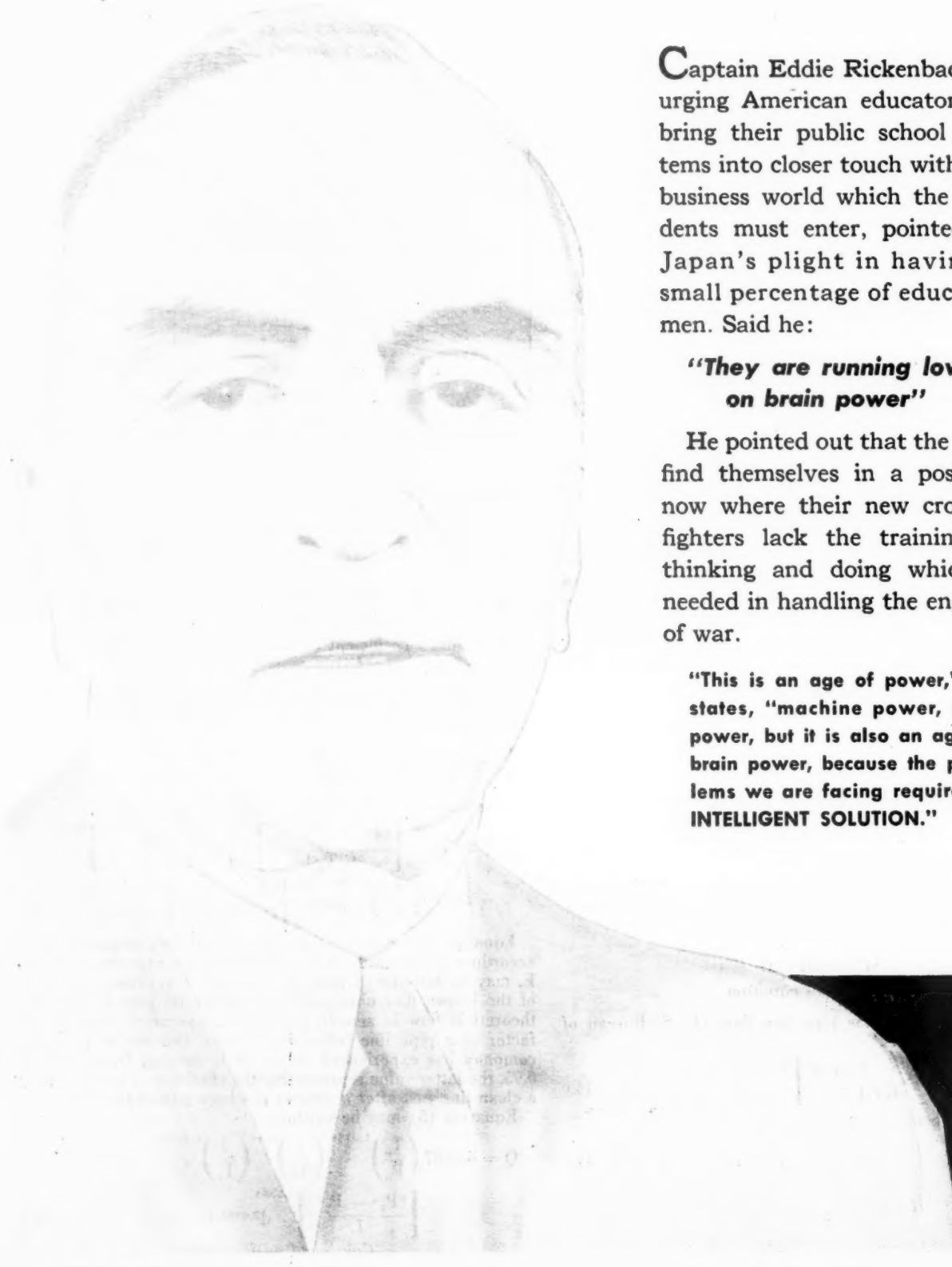
Equation (5) may be written:

$$Q = 435.87\left(\frac{T_o}{P_o}\right)^{1.0788}\left(\frac{1}{G}\right)^{0.46}\left(\frac{1}{T_f}\right)^{0.8394} \times \left[\frac{(P_1^2 - P_2^2)}{L}\right]^{0.5394} d^{2.6182}\ E. \quad (6)$$

(Continued on Page 156)

then he said to himself

"They're Short on Brains"



Captain Eddie Rickenbacker, urging American educators to bring their public school systems into closer touch with the business world which the students must enter, pointed to Japan's plight in having a small percentage of educated men. Said he:

"They are running low on brain power"

He pointed out that the Japs find themselves in a position now where their new crop of fighters lack the training in thinking and doing which is needed in handling the engines of war.

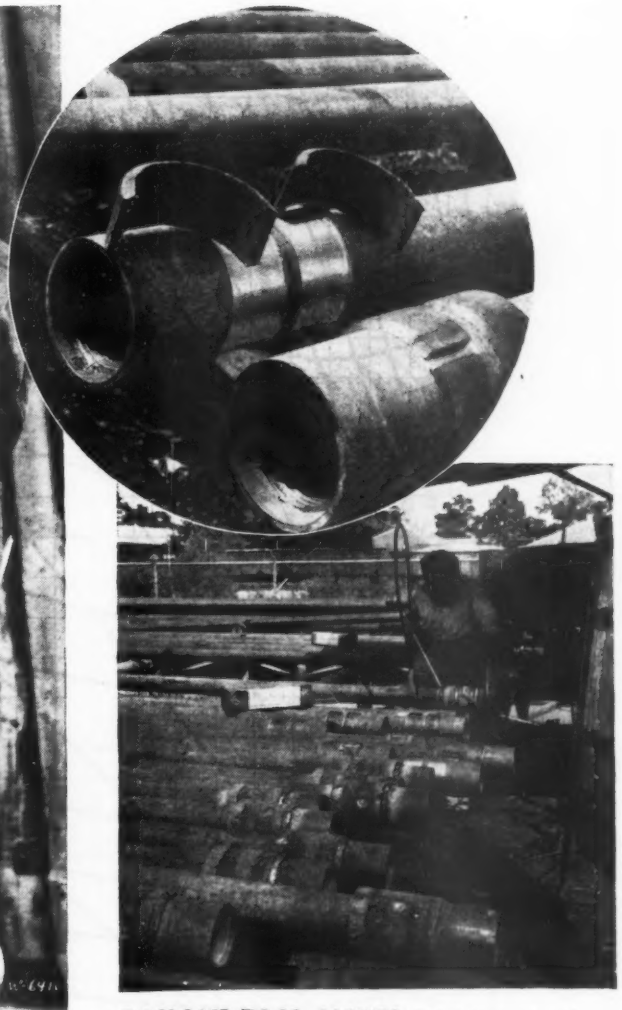
"This is an age of power," he states, "machine power, man power, but it is also an age of brain power, because the problems we are facing require an INTELLIGENT SOLUTION."

"INTELLIGENT SOLUTION," *he says*

LOOK, CAPTAIN, how recourse to Arc Welding affords intelligent solutions to oil country problems:

OIL PRODUCTION SIMPLIFIED

GET A 100% JOINT. Arc Welding of casing provides higher joint strength, eliminates leakage, cuts cost of casing, reduces size of hole. This well has Grade C casing with plain end, V-bevelled joints. Further details on welding of casing on Pages 1050-1055 of Lincoln "Procedure Handbook."



RECLAIM TOOL JOINTS. Weld steel clips (see insert) to box end of worn pipe with "Fleetweld 9 HT" Electrode. Then build up wearing surfaces with "Wearweld." Full details on Page 1059, Lincoln "Procedure Handbook."

Consult the Lincoln Welding Engineer nearby for the intelligent solution of your welding problems

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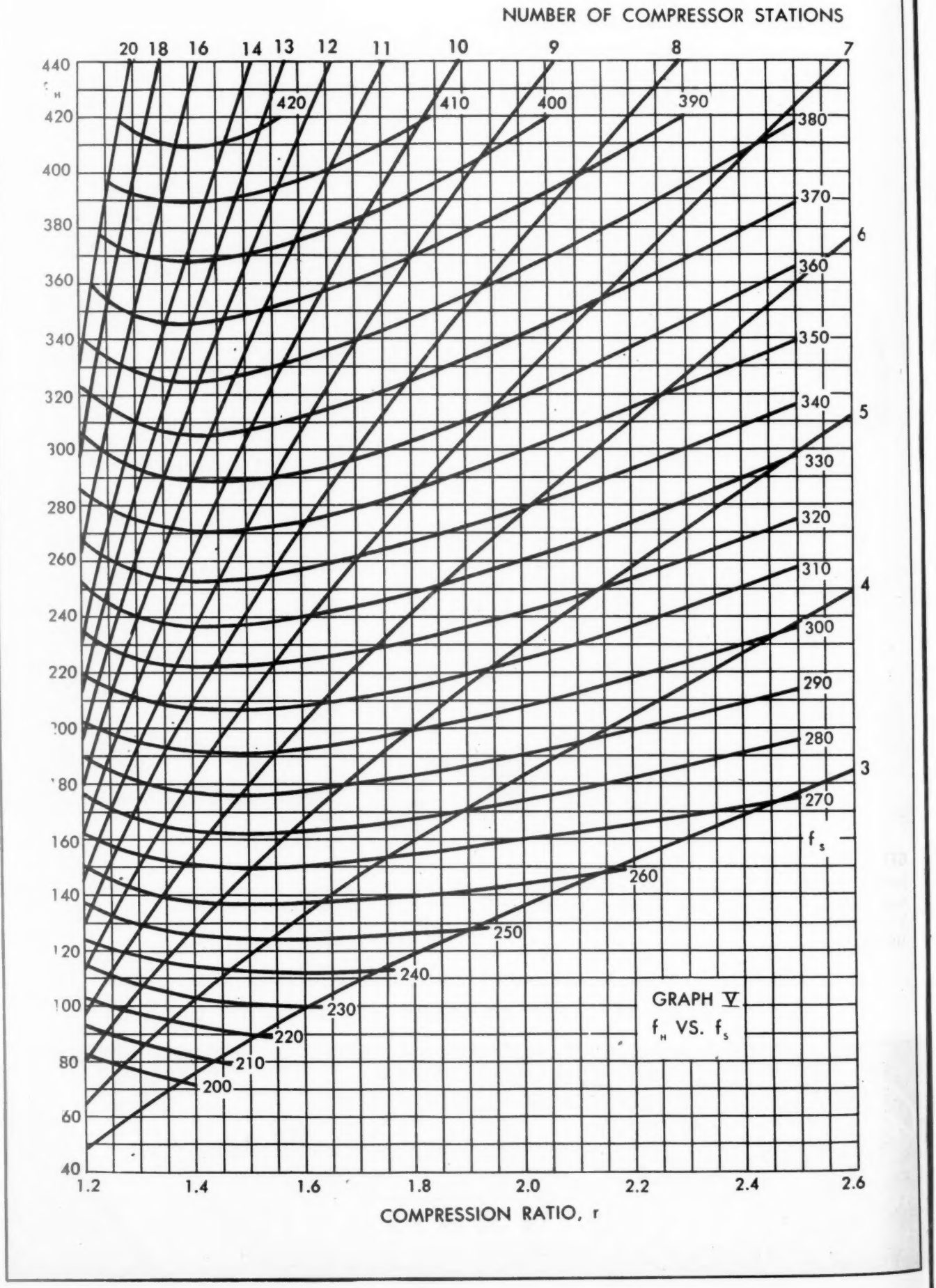
ARC WELDING

(Continued from Page 153)



Putting $T_o = 520°$ F. abs.
$T_f = 510°$ F. abs.
$P_o = 14.735$ lb. per sq. in. abs.
$G = 0.607$
$E = 0.925$

$$Q = 821\ d^{2.6182}\left[\frac{(P_1^2 - P_2^2)}{L}\right]^{0.5394} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

As $P_1/P_2 = r$, $P_2 = P_1/r$, and equation (7) can be written:

$$Q = 821\ d^{2.6182}\ P_1^{1.08}\left(\frac{r^2-1}{r^2}\right)^{0.5394}\left(\frac{1}{L}\right)^{0.5394} \quad . \quad . \quad . \quad . \quad (8)$$

Equations (7) and (8) are used throughout this analysis as the general flow equations.

APPENDIX III

Derivation of equations for total horsepower and fuel

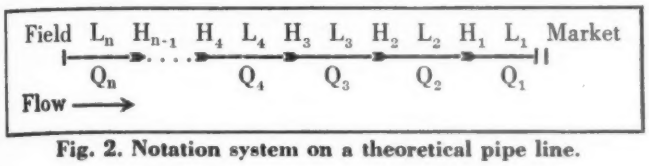


Fig. 2. Notation system on a theoretical pipe line.

Section	Length	Flow	Station	Horsepower	Fuel
1	L_1	Q_1	H_1	$=bQ_1$	abQ_1
2	L_2	$Q_2=Q_1(1+ab)$	H_2	$=bQ_1(1+ab)$	$abQ_1(1+ab)$
3	L_3	$Q_3=Q_1(1+ab)^2$	H_3	$=bQ_1(1+ab)^2$	$abQ_1(1+ab)^2$
4	L_4	$Q_4=Q_1(1+ab)^3$	H_4	$=bQ_1(1+ab)^3$	$abQ_1(1+ab)^3$
n	L_n	$Q_n=Q_1(1+ab)^{n-1}$	H_{n-1}	$=bQ_1(1+ab)^{n-2}$	$abQ_1(1+ab)^{n-2}$

Total horsepower for n sections or (n—1) stations; (the field station is excluded):

$$H_t = H_1 + H_2 + H_3 + H_4 + \ldots H_{n-1} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

$$= bQ_1[1+(1+ab)+(1+ab)^2+(1+ab)^3+\ldots + (1+ab)^{n-2}] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

$$= bQ_1\left[\frac{(1+ab)^{n-1}-1}{(1+ab)-1}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

$$= \frac{Q_1}{a}\left[(1+ab)^{n-1}-1\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

Total fuel for n sections or (n—1) stations; (the field station is excluded):

$$F_t = aH_t = Q_1\left[(1+ab)^{n-1}-1\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

APPENDIX IV

Derivation of equations for graduating the interval between compressor stations to obtain the same compression ratio at full load

The general flow equation can be written:

$$Q = k\ d^{2.618}\left[\frac{(P_1^2 - P_2^2)}{L}\right]^{0.54}$$

$$(P_1^2 - P_2^2)^{0.54} = \frac{Q\ L^{0.54}}{k^{1.85}}$$

$$(P_1^2 - P_2^2) = \frac{L\ Q^{1.85}}{k^{1.85}}$$

$$L\ Q^{1.85} = k^{1.85}\ (P_1^2 - P_2^2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

For any given pipe line, if the compression ratio is the same and constant at all compressor stations, $(P_1^2 - P_2^2)$ must be equal and constant for each section and:

$$L_nQ_n^{1.85} = K \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

Where:

L_n = length of section, miles, and

Q_n = flow in section, million cu. ft. per 24 hr.

The relationship between flow and length is shown in the following series:

Section	Length	Flow	$L_nQ_n^{1.85} = K$	
1	L_1	Q_1	$L_1Q_1^{1.85}$	$= K$
2	L_2	$Q_1(1+ab)$	$L_2Q_1^{1.85}\ (1+ab)^{1.85}$	$= K$
3	L_3	$Q_1(1+ab)^2$	$L_3Q_1^{1.85}\ (1+ab)^{1.85\times2}$	$= K$
4	L_4	$Q_1(1+ab)^3$	$L_4Q_1^{1.85}\ (1+ab)^{1.85\times3}$	$= K$
5	L_5	$Q_1(1+ab)^4$	$L_5Q_1^{1.85}\ (1+ab)^{1.85\times4}$	$= K$
n	L_n	$Q_1(1+ab)^{n-1}$	$L_nQ_1^{1.85}\ (1+ab)^{1.85(n-1)}$	$= K$

$$L_1Q_1^{1.85} = L_2Q_1^{1.85}\ (1+ab)^{1.85} = L_3Q_1^{1.85}\ (1+ab)^{1.85\times2} = L_nQ_1^{1.85}\ (1+ab)^{1.85(n-1)} = K \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

$$\frac{L_2}{L_1} = \frac{Q_1^{1.85}}{Q_1^{1.85}\ (1+ab)^{1.85}} \text{ and } L_2 = \frac{L_1}{(1+ab)^{1.85}} \quad . \quad . \quad . \quad (17)$$

$$\frac{L_3}{L_1} = \frac{Q_1^{1.85}}{Q_1^{1.85}\ (1+ab)^{1.85\times2}} \text{ and } L_3 = \frac{L_1}{(1+ab)^{1.85\times2}} \quad . \quad (18)$$

$$\frac{L_n}{L_1} = \frac{Q_1^{1.85}}{Q_1^{1.85}\ (1+ab)^{1.85(n-1)}} \text{ and } L_n = \frac{L_1}{(1+ab)^{1.85(n-1)}} \quad (19)$$

$$L_t = L_1 + L_2 + L_3 + \ldots + L_n \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

$$= L_1\left[1 + \frac{1}{(1+ab)^{1.85}} + \frac{1}{(1+ab)^{1.85\times2}} + \frac{1}{(1+ab)^{1.85\times3}} + \ldots + \frac{1}{(1+ab)^{1.85(n-1)}}\right] \quad . \quad . \quad (21)$$

$$= L_1\left[\frac{\left[\left[\frac{1}{(1+ab)}\right]^{1.85n} - 1\right]}{\left[\left[\frac{1}{(1+ab)}\right]^{1.85} - 1\right]}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

$$= L_1\left[\frac{1-(1+ab)^{1.85n}}{(1+ab)^{1.85n}}\right]\left[\frac{(1+ab)^{1.85}}{1-(1+ab)^{1.85}}\right] \quad (23)$$

$$= L_1\left[\frac{1-(1+ab)^{1.85n}}{1-(1+ab)^{1.85}}\right]\left[\frac{1}{(1+ab)^{1.85(n-1)}}\right] \quad (24)$$

$$\frac{L_1}{L_t} = \frac{[1-(1+ab)^{1.85}]\ \ (1+ab)^{1.85(n-1)}}{1-(1+ab)^{1.85n}} \quad (25)$$

APPENDIX V

Derivations of significant factors and their use as mathematical operatives in the solution of pipe line problems

The general flow equation for the standard conditions stated in Appendix I is written:

$$Q_1 = \frac{821}{10^6}\left(\frac{r^2-1}{r^2}\right)^{0.54}\frac{P_1^{1.08}d^{2.618}}{L_1^{0.54}}$$

Where:

Q_1 = deliverability of market terminal section, million cu. ft. per 24 hr.,

L_1 = Length of terminal section, miles,

P_1 = maximum allowable discharge pressure, lb. per sq. in. abs.,

r = ratio of compression, and

d = inside diameter of pipe, in.

The common formula for the maximum working pressure at the allowable circumferential stress in thin-walled tubes is as follows:

$$P_1 = \frac{2st}{\Phi\ d} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

Where:

P_1 = maximum allowable working pressure, lb. per sq. in.,

t = wall thickness, in.,

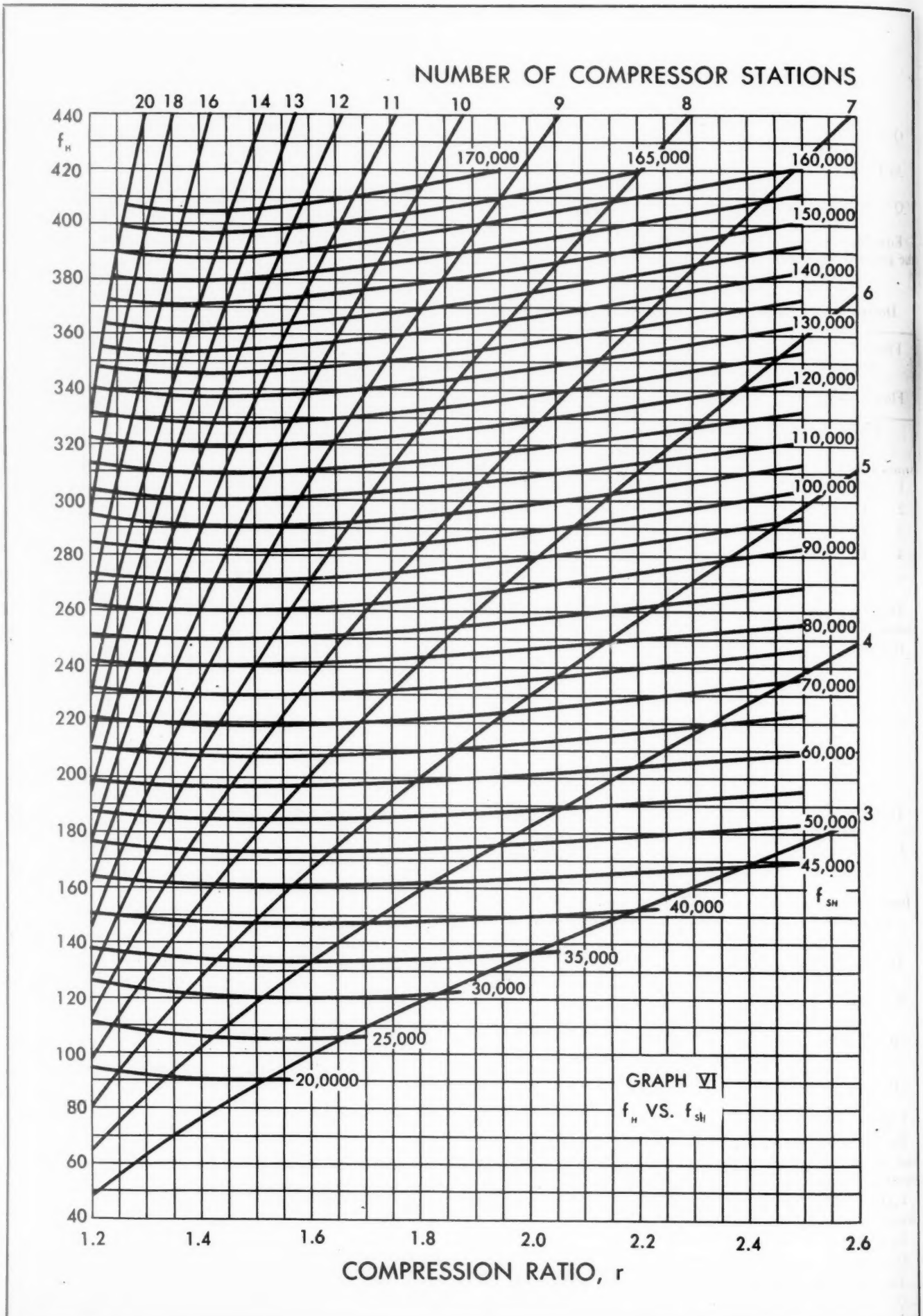
d = inside diameter, in.,

Φ = design factor of safety, and

s = ultimate fiber stress of material, lb. per sq. in.

For Grade "B" steel stressed to 35,715 lb. per sq. in., $\Phi = 1.4$ and

$$P_1 = \frac{2 \times 50{,}000\ t}{1.4\ d} = \frac{10^5 t}{1.4d} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$


NUMBER OF COMPRESSOR STATIONS
20 18 16 14 13 12 11 10 9 8 7
440
f_H
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
170,000
165,000
160,000
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
45,000
40,000
35,000
30,000
25,000
20,0000
6
5
4
3
f_{SH}
GRAPH VI
f_H VS. f_{SH}
1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6
COMPRESSION RATIO, r

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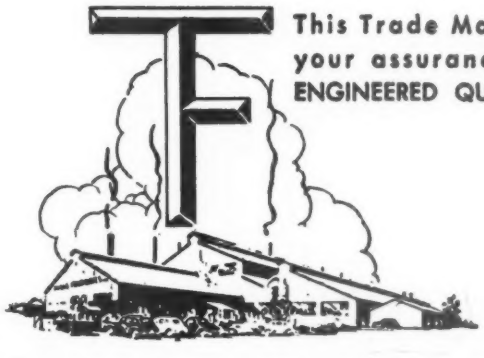

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Substituting the above value of P_1 in the general flow equation:

$$Q_1 = \frac{821}{10^6}\left(\frac{r^2-1}{r^2}\right)^{0.54}\left(\frac{10^5 t}{1.4d}\right)^{1.08}\frac{d^{2.618}}{L_1^{0.54}} \quad . \quad . \quad . \quad . \quad (28)$$

$$= \frac{821 \times 10^{5.40}}{10^6 \times 1.438}\left(\frac{r^2-1}{r^2}\right)^{0.54}\frac{t^{1.08}\, d^{2.618}}{d^{1.08}\, L_1^{0.54}} \quad . \quad . \quad . \quad (29)$$

$$= 143.5\left(\frac{r^2-1}{r^2}\right)^{0.54}\frac{t^{1.08}\, d^{1.538}}{L_1^{0.54}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (30)$$

Multiplying equation (30) by $(L_t)^{0.54}$ and dividing by $(t^{1.08}\, d^{1.538})$:

$$\frac{Q_1\, L_t^{0.54}}{t^{1.08}\, d^{1.538}} = 143.5\left(\frac{r^2-1}{r^2}\right)^{0.54}\left(\frac{L_t}{L_1}\right)^{0.54} \quad . \quad . \quad (31)$$

Substituting for $\left(\frac{L_t}{L_1}\right)$ the reciprocal of equation (25) in Appendix IV, equation (31) becomes:

$$\frac{Q_1\, L_t^{0.54}}{t^{1.08}\, d^{1.538}} = 143.5\left(\frac{r^2-1}{r^2}\right)^{0.54} \times$$

$$\left[\frac{1-(1+ab)^{1.85n}}{[1-(1+ab)^{1.85}]\ (1+ab)^{1.85(n-1)}}\right]^{0.54} \quad . \quad . \quad . \quad (32)$$

Equation (32) may be written:

$$\frac{Q_1\, f_L}{f_P} = f_S \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

Where:

f_L = length factor = $L_t^{0.54}$

f_P = pipe factor = $t^{1.08}\, d^{1.538}$

f_S = station factor = $143.5 \times$

$$\left(\frac{r^2-1}{r^2}\right)^{0.54}\left[\frac{1-(1+ab)^{1.85n}}{[1-(1+ab)^{1.85}]\ (1+ab)^{1.85(n-1)}}\right]^{0.54}$$

It is readily apparent that f_L is a function of the total length of the pipe line and f_P is a function of the wall thickness and diameter of the pipe. When f_L and f_P are combined with Q_1, the deliverability of the terminal section, as shown in equation (33), the result is a station factor, f_S, which is a complex function of the number of compressor stations, compression ratio, fuel, and the compressor b.hp. required for each compression per million cu. ft. pumped per 24 hr.

In Appendix III it was shown that:

$$H_t = \frac{Q_1\,[(1+ab)^{n-1}-1]}{a}$$

where H_t = total compressor b.hp. in all stations except the field station.

The above equation may be written:

$H_t = Q_1\, f_H$

where f_H = hp. factor $= \dfrac{(1+ab)^{n-1}-1}{a}$ . . . . . (34)

The horsepower factor, f_H, may be defined as the total compressor b.hp. required in all stations (except the field station) per million cu. ft. delivered per 24 hr. at the market terminus.

For the solution of certain types of problems where Q_1 is unknown it is convenient to use a mathematical operative, f_{SH}, which is the product of f_S and f_H. Thus:

$$f_{SH} = f_S \times f_H \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (35)$$

$$= \frac{f_L\, Q_1}{f_P} \times \frac{H_t}{Q_1} = \frac{f_L\, H_t}{f_P} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (36)$$

It is axiomatic that at optimum design conditions, for any value of f_S or f_{SH}, the value of f_H must be the minimum. On Graph V loci of constant values of f_S are superimposed on the f_H curves to show the range of minimum values of f_H. By inspection it is apparent that the optimum ratio of compression exceeds 1.4 for all values of f_H up to 400. As 400 b.hp. per million cu. ft. of daily deliverability is a very high compressor saturation for even a long pipe line, 1.4 is, for all practical purposes, a lower limit for optimum ratios of compression.

Similar curves are constructed on Graph VI, using loci of constant values of f_{SH} superimposed on f_H curves to show the minimum values of f_H. Minimums are not as sharply defined in the latter graph and it is always preferable to use Graph V for finding optimum solutions whenever possible.

On Graph VII are plotted minimum values of f_H against corresponding values of f_S and f_{SH} taken from Graphs V and VI. Graph VII is especially useful for finding optimum solutions of a given problem involving many combinations of compressor horsepower and pipe size.

GRAPHS

Graph I plots values of f_L vs. L_t.

Graph II plots values of f_P vs. O.D. and wall thickness of pipe.

Graph III plots values of f_S and f_H vs. ratio of compression and the number of compressor stations, for pipe stressed to 35,715 lb. per sq. in. and compressors having a mechanical efficiency of 90 per cent.

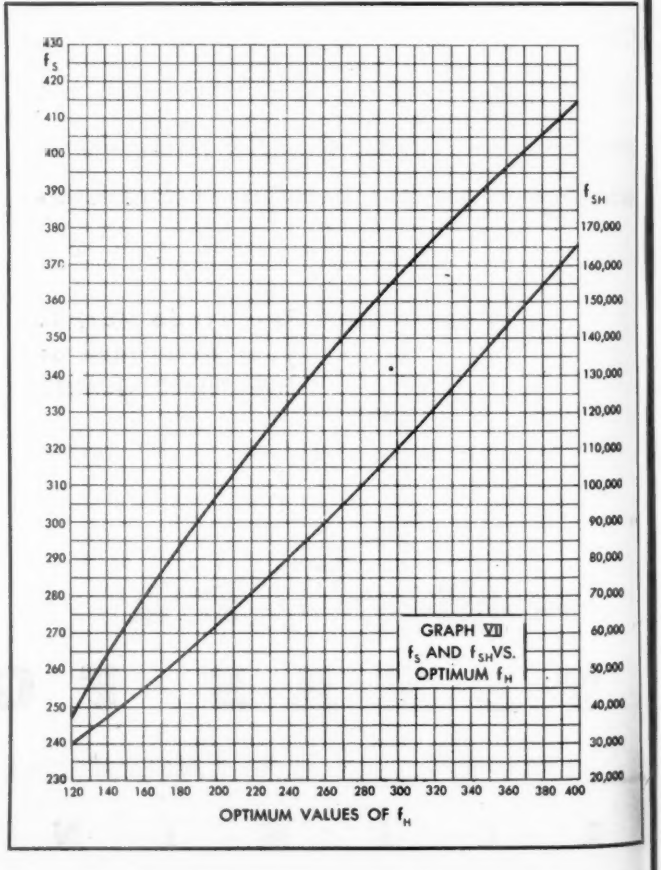
Graph IV plots values of f_{SH} and f_H vs. ratio of compression and the number of compressor stations, for pipe stressed to 35,715 lb. per sq. in. and compressors having a mechanical efficiency of 90 per cent.

Graphs IIIA, IIIB, and IVA, respectively, plot values of f_S, f_H, and f_{SH} vs. ratio of compression and the number of compressor stations over a wider range than that covered by Graphs III and IV.

Graph V plots the loci of constant f_S at certain values against f_H for various compression ratios and numbers of stations, for pipe stressed to 35,715 lb. per sq. in. and compressors having a mechanical efficiency of 90 per cent.

Graph VI plots the loci of constant f_{SH} at certain values against f_H for various compression ratios and numbers of stations, for pipe stressed to 35,715 lb. per sq. in. and compressors having a mechanical efficiency of 90 per cent.

Graph VII plots the optimum values of f_H vs. f_S and f_{SH}, for pipe stressed to 35,715 lb. per sq. in. and compressors having a mechanical efficiency of 90 per cent.



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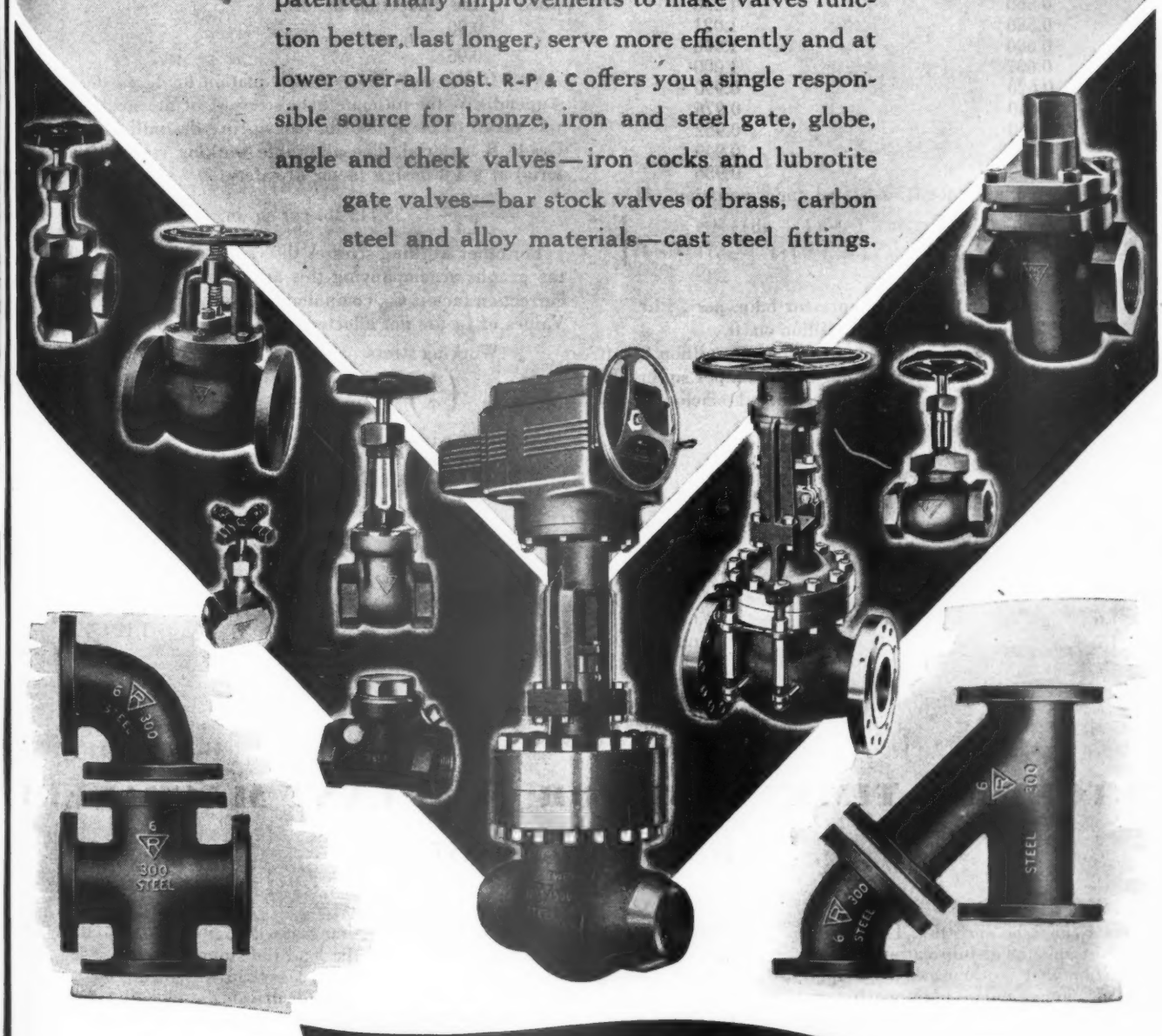

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The following standard conditions and values of constants were used to compute the graphs:

(a) In the flow equation, as stated in Appendix II:

$T_o = 520°$ F. abs.
$T_f = 510°$ F. abs.
$P_o = 14.735$ lb. per sq. in. abs.
$G = 0.607$
$E = 0.925$

Values of f_S and f_{SH} are affected by changes in the above assumed conditions and should be multiplied by a correction factor computed as indicated by equation (6) in Appendix II. The other factors are not affected by changes in the flow conditions.

Changes in specific gravity are most often encountered in flow problems and a few correction factors, C_G, for specific gravity are computed as follows:

Sp. gr. G	Correction factor $C_G = (0.607/G)^{0.46}$
0.560	1.038
0.580	1.021
0.600	1.006
0.607	1.000
0.620	0.990
0.640	0.976
0.660	0.962
0.680	0.949
0.700	0.936

(b) In the equation for f_S, as stated under equation (33):

$$f_s = 143.5\left(\frac{r^2-1}{r^2}\right)^{0.54}\left[\frac{1-(1+ab)^{1.85n}}{[1-(1+^{1.85}](1+ab)^{1.85(n-1)}}\right]^{0.54}$$

Where:

a = fuel gas consumed per compressor b.hp. per 24 hr. $= 11 \times 24 \times 10^{-6} = 0.000264$ million cu. ft.

b = compressor b.hp. required to pump one million cu. ft. of gas per 24 hr. (measured at 14.735 lb. per sq. in. abs. and suction temperature), mechanical efficiency = 90 per cent and $c_p/c_v = 1.275$ as follows:

Compression ratio (r)	B.hp. per million cu. ft. per 24 hr. (b)	(1 + ab)
1.2	15.9	1.004198
1.3	21.0	1.005544
1.4	25.4	1.006706
1.5	29.3	1.007735
1.6	32.8	1.008659
1.7	36.4	1.009610
1.8	39.3	1.010375
1.9	42.1	1.011114
2.0	44.8	1.011827
2.1	47.5	1.012540
2.2	50.1	1.013226

(c) Values of f_S on the graphs are affected only negligibly by minor changes in the value of b such as the change brought about by the difference in mechnical efficiency of horizontal and angle type compressors. On the other hand, values of f_H and f_{SH} are affected in direct proportion to the value of b. For most gases the change in b caused by normal variations in the c_p/c_v ratio is too small to take into account in the graphs, but when they are used for horizontal compressors having a mechanical efficiency of 90 per cent, values of f_H and f_{SH} must be multiplied by the correction factor,

$$C_E = \frac{0.90}{0.95} = 0.947$$

(d) In the derivation of the equation for f_S, as described in Appendix V, the ultimate fiber stress, s, of the steel in the pipe was taken to be 50,000 lb. per sq. in., the mill guarantee for Grade B material. The allowable working stress of such material at a 1.4 design factor of safety:

$$\frac{s}{\Phi} = \frac{50{,}000}{1.4} = 35{,}715 \text{ lb. per sq. in.}$$

For other working stresses the values of f_S and f_{SH} shown on the graphs accompanying this article must be multiplied by a correction factor, C_S, computed as shown in the following table. Values of f_H are not affected by changes in the working stress.

Working stress $\left(\frac{s}{\Phi}\right)$	Correction factor $C_S = \left(\frac{s}{\Phi \times 35{,}715}\right)^{1.08}$
26,000	0.690
28,000	0.753
30,000	0.815
32,000	0.878
34,000	0.943
35,715	1.000
36,000	1.008
38,000	1.068
40,000	1.129

★ ★ ★

P 094.7

"STOPPING TIME" TEST FOR OIL PLANT MACHINERY

By W. F. SCHAPHORST

"How can I be sure that I am using the right amount of lubricating oil?" is a question that is often asked by operators of refinery and oil plant machinery. The answer, too often, is made so complex that it cannot be understood.

The "stopping time test" is an excellent one for determining proper lubrication. The test is very simple. For instance, if you wish to determine whether a given steam engine is properly lubricated, just pull out your watch and take the time required for the engine to come to a stop after shutting off the steam. The longer the stopping time the better.

It is plain that if a flywheel weighs, say 2000 lb., it has a definite amount of energy stored in it when running at normal speed. Therefore, when steam is suddenly shut off an equal amount of energy is dissipated each time the engine stops. With all conditions the same, then, an exactly identical length of time will be consumed in stopping each time the throttle is closed. By noting the stopping time each night and by altering the quantity of lubricant fed to the engine each day, the proper quality and amount of lubricant can easily be determined in a period of time.

If the engine drives machinery, as engines generally do, try the stopping time test with and without the load. With the load the stopping time, of course, is much less than without the load.

Motor-driven, diesel-engine-driven, and turbine-driven plants often can be tested in the same way. The fly wheel effect of pulleys on lineshafts and on the machinery itself is sometimes sufficient to cause the machinery to operate for some time after the power is shut off. It is logical that as long as there is a difference in stopping time, all other conditions being the same, there is a difference in lubrication. The thing to do is: Make the stopping time as long as possible.

★ ★ ★

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GOOD NEWS — FWD four-wheel-drive trucks, pre-eminent in war services, with production previously restricted almost exclusively for the military, are soon to be available for motor transport, highway, utility, oil fields, and other essential civilian services.

Recent directive from the WPB provides for production of substantial number of FWD trucks in a wide variety of models and types, 2½ to 15 tons capacity; such trucks to be built only for essential civilian uses. FWD trucks built under this release will be available for purchase on and after January 1, 1945. Deliveries will be made in keeping with priority of orders as received; immediate action and prompt placing of orders is urgent to assure delivery before limit of production is reached.

Write—wire—or phone us directly, or the nearest authorized FWD dealer for full information and your eligibility to purchase under these new rationing regulations.

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NAVY

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TRUCKS

SALT WATER DISPOSAL IN EAST TEXAS

Reservoir pressure behavior. The first consideration in reservoir pressure behavior is the type of reservoir control. Reservoirs are usually classified in three groups:

1. *Water drive.*
2. *Gas cap drive.*
3. *Dissolved gas drive.*

Most reservoirs derive energy from all three sources and the one that is to predominate depends upon how the reservoir is handled. Water drive is the most efficient and dissolved gas drive the least efficient. (Many fields that have been depleted by dissolved gas drive have produced more oil by a secondary recovery water flood than they produced under natural conditions.)

EXCLUSIVE

Recoveries under water drive can be expected to be 80 per cent or more of the oil in place; recoveries from gas cap drive reservoirs are usually about 60 per cent and can, if fully utilized and under favorable conditions, approximate the efficiency of a water drive reservoir. Recoveries under dissolved gas drive are between 20 and 40 per cent of the oil in place.

Dissolved gas drive is the expansion of gas as it comes out of solution with the oil when no free gas cap or water source is present. This type of drive may be approached in fields having a gas cap and a source of water, if production rates are excessively high, or gas is produced from the gas cap.

In gas cap drive the downward expansion of the gas cap maintains pressure on the oil column and prevents or retards the release of dissolved gas from the oil. In fields where a gas cap does not exist it is often beneficial to create one by injecting gas at the highest structural position. Gas injection is also used to expand an original gas cap with a lesser pressure reduction.

An efficient water drive depends on several factors. First there must be a large volume of water contained in a porous and permeable formation and in contact with the oil. The permeability of the reservoir rock and the area of contact between oil and water must be great enough to allow water influx at a rate to allow economic production without undue loss in reservoir pressure. The production rate must be regulated to the speed of water influx or portions of the reservoir will be controlled by dissolved gas or gas cap drive. Because of the low compressibility of water the expansion of water as a means of oil displacement was overlooked and water drive thought possible only when the oil

Fig. 20. Generalized East-West cross-section of the East Texas field.

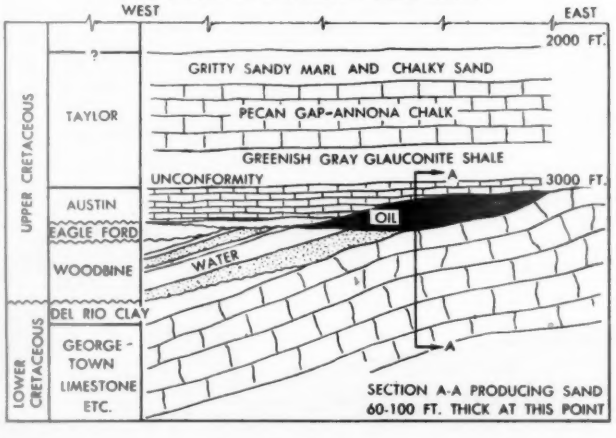
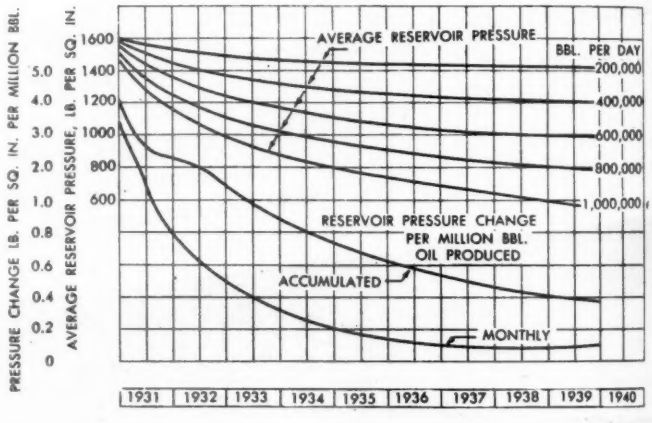


Fig. 21. Calculated change of reservoir pressure with time at constant production rate.



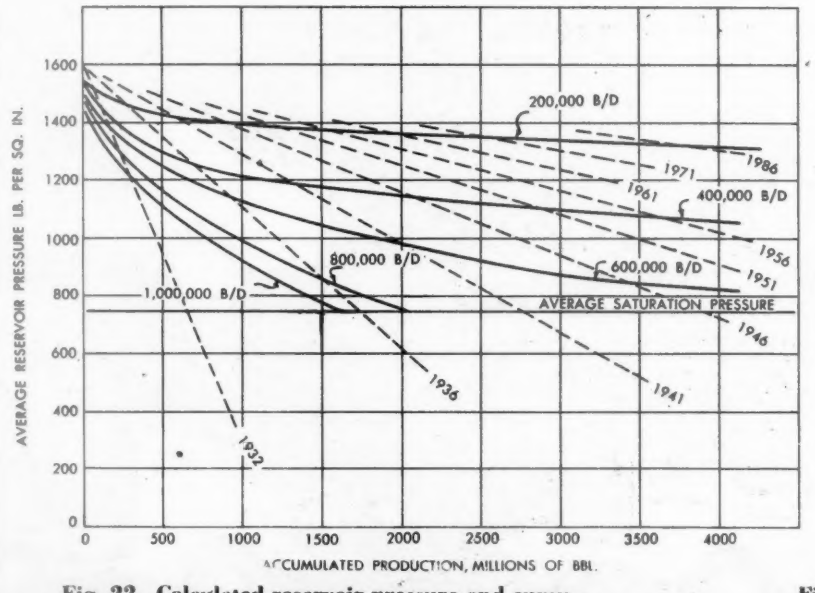


Fig. 22. Calculated reservoir pressure and cumulative production at constant production rate.

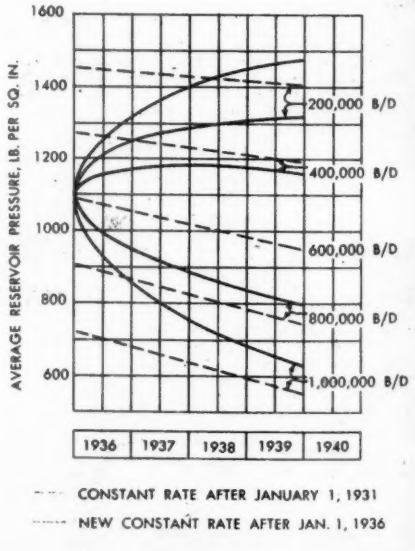


Fig. 23. Calculated effect of variation of production rate on reservoir pressure.

bearing zone outcropped near the field. However, due to the large volume of water in contact with the oil in many fields only a slight expansion is necessary to displace the oil. It should be remembered that under water expansion the efficient rate of a water drive will decrease as the pressure is reduced farther away from the oil-water contact.

The initial reservoir pressure in the East Texas field was approximately 1620 lb. per sq. in. at 3320 ft. subsea. This pressure is roughly equal to the head of water between the reservoir and the Woodbine outcrop. The compressibility of the oil is not great (approximately 0.1 per cent per 100 lb. per sq. in). If there had been no water drive the oil produced in the first few months would have been sufficient to lower the reservoir pressure below saturation pressure and dissolved gas drive would have followed.

In any water drive field the rate of pressure decline depends upon the rate of production. Fig. 22 shows theoretical pressure behavior of the East Texas field under various constant production rates (this figure and the succeeding ones on reservoir pressure behavior of the East Texas field were taken from Stuart Buckley's work on pressure-production relationships).

A study of these curves shows that at any constant production rate the pressure decline rate can be calculated. The greater the production rate, the more rapid is the pressure decline. It is necessary for conservation purposes to produce the field at a rate that will allow depletion of the reserve by the time the pressure declines to the saturation pressure of 740 lb. per sq. in. Depletion of the reservoir at a greater final pressure is desirable in that it will reduce lifting costs by allowing a greater part of the oil to be produced by natural flow.

As shown by the pressure history of the field, the reservoir is very sensitive to changes in production rate. Pressures build up rapidly during shut-in periods or periods of reduced withdrawal. The field pressure at any time tends to approach the curve it would have followed if the withdrawal had been constant at the rate in effect. For instance, assume that the field was being produced at the rate of 800,000 bbl. per day and that the rate were reduced to 600,000 bl. per day. In that case the pressure would increase and approach the curve it would have followed had it produced at 600,000 bbl. constantly. Conversely, if the field were producing at 600,000 bbls. per day and following that curve and the rate were increased to 800,000 bbl., the pressure would drop sharply and would approach and become an asymptote to the curve it would have followed if it had produced constantly at 800,000 bbl. per day.

Our brief review of geological principles influencing the occurrence of oil and gas has considered the following subjects:

1. **Origin of oil and gas.**
2. **Sedimentary processes.**
3. **Petroleum reservoirs formed by structural and stratigraphic traps.**
4. **Electrical logging as a means of intepreting reservoirs.**

In the course of our discussion of these principles we have frequently re-

Fig. 24. Virgin field with gas in solution—no water drive or free gas cap.

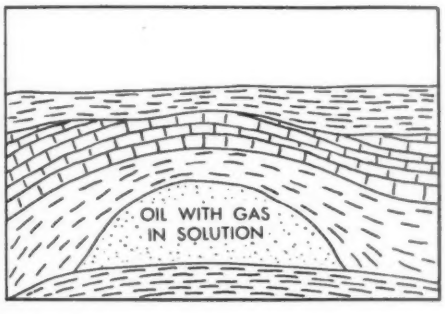


Fig. 25. Virgin field with gas in solution after the first well was drilled.

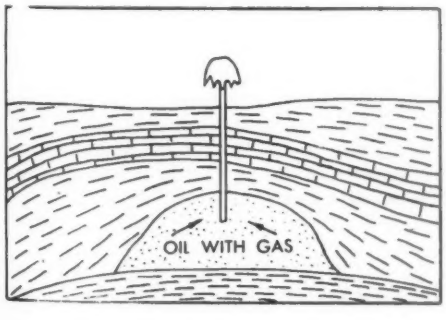


Fig. 26. Field after gas has come out of solution and has been produced.

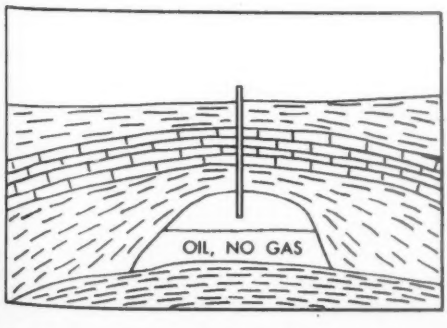


Fig. 27. Unopened bottle of pop.

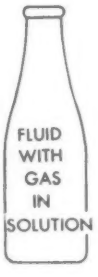


Fig. 28. Bottle of pop opened.

Fig. 29. After carbon dioxide has escaped.

Fig. 30. Virgin field with free gas cap —no water drive or gas in solution.

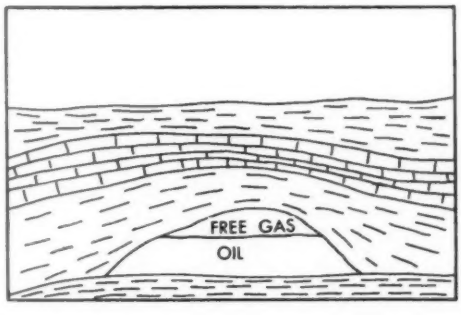


Fig. 31. Virgin field with free gas cap after the first well is drilled.

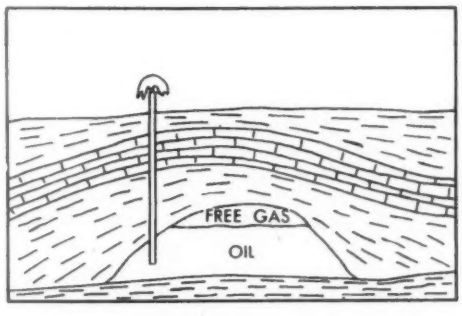


Fig. 32. Field after gas expanded leaving some oil in reservoir.

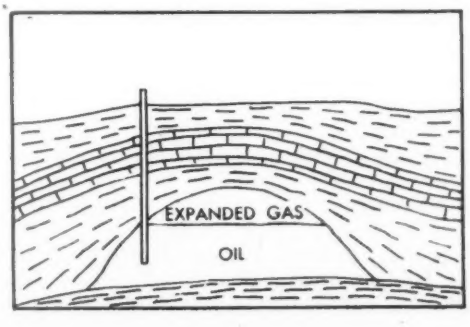


Fig. 33. Barrel of water with compressed air.

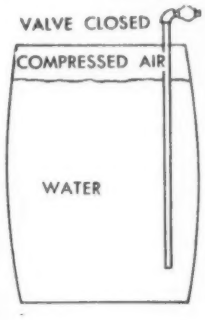


Fig. 34. Barrel after the valve is opened.

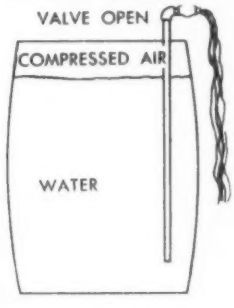
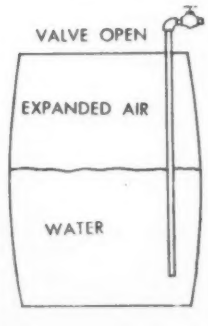


Fig. 35. Air has expanded and part of water is left.



ferred to the East Texas field in illustrating certain points, but we are now prepared to discuss the East Texas reservoir in greater detail through application of the principles previously discussed.

Now that we have studied geology and some of the phases of the reservoir behavior, we should be able to apply some of these data to our East Texas field.

The East Texas field is located on the western slope of the Sabine uplift. The principal structural features of the field are: (1) Shore-line type of deposition of the Woodbine formation, and (2) its partial erosion and subsequent overlap by the Austin chalk, which is an effective sealing medium. As indicated on the structural map of northeast Texas (Fig. 1, first installment of series), the original shore-line deposition of the Woodbine formation probably extended about 10 to 20 miles farther east from its present limit, and the subsequent erosion, after more pronounced elevation of the Sabine Uplift, resulted in the recession of the eastern limits of Woodbine sediments, which made up the Woodbine series were derived principally from the north and the northeast and not from the Sabine Uplift as was considered at one time. The probable geological sequence of events relative to the East Texas field were as follows: After deposition of the lower Cretaceous (Comanche) formations these sediments were uplifted in northern Louisiana and southern Arkansas, the Sabine Uplift in northwestern Louisiana coming into existence at that time. After this uplift the Lower Cretaceous sediments were truncated and the resulting topography was represented by a plain of low relief. The subsequent deposition of the Woodbine was, as indicated, around the western limit of the Sabine Uplift, at which time this uplift was evidently accentuated, as is indicated by the absence of Woodbine formations over the uplift. After deposition of the Woodbine sands, the Austin sea transgressed the Sabine Uplift and extended well into Louisiana resulting in the present overlap by the Austin sediments of Eagle Ford and Woodbine. The subsequent sedimentation in the East Texas basin continued without breaks of major magnitude until the present date, except for an unconformity at the base of the Tertiary.

The structural map of northeast Texas (Fig. 1.), shows that the Woodbine sand outcrops at the elevations of from 500 to 700 ft. in a belt from McLennan County north to Cooke County, then swings east and follows the course of the Red River to the Arkansas line. This map also shows that the sand dips from its outcrop to the center of the East Texas basin and continues to the east, rising out of the basin and terminating on the west flank of the Sabine Uplift.

The structural and stratigraphic trap that has accumulated the gas and oil is created by the termination of the sand against the chalk above and the shale below, both being relatively impervious.

The Woodbine formation is composed of strata of sand, shale, gravel, and altered volcanic ash, with all gradations of compositions of these materials. The shale and ash beds occur as lenses in the sand body and their lateral extent is limited to a few thousand feet. No single shale stratum has been identified over any great distance. The Woodbine sand is, for all practical purposes, a continuous permeable formation that forms a single reservoir. The top of the sand is irregular, probably resulting from erosion while the sand was exposed at the surface.

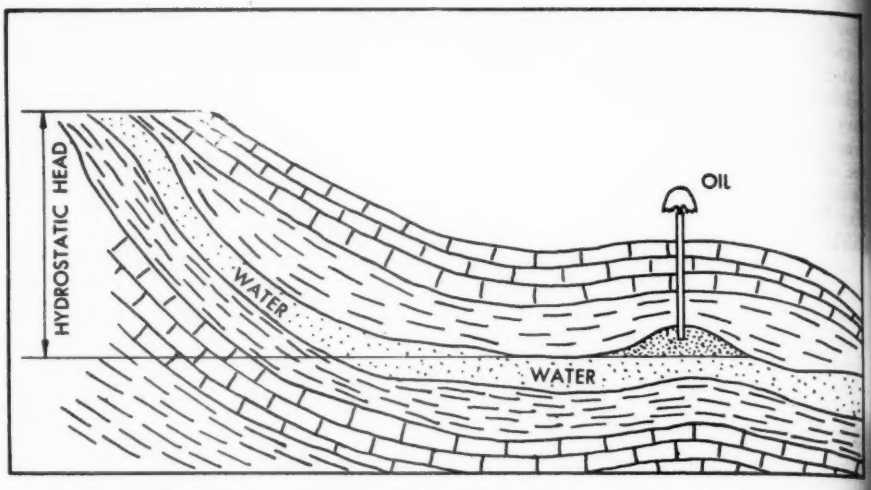


Fig. 36. Reservoir with water drive and no gas cap or gas in solution.

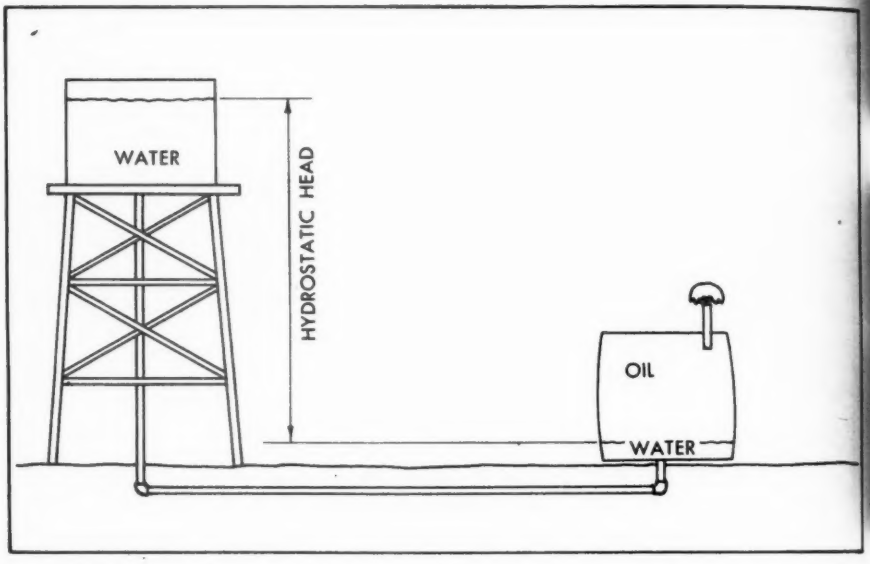
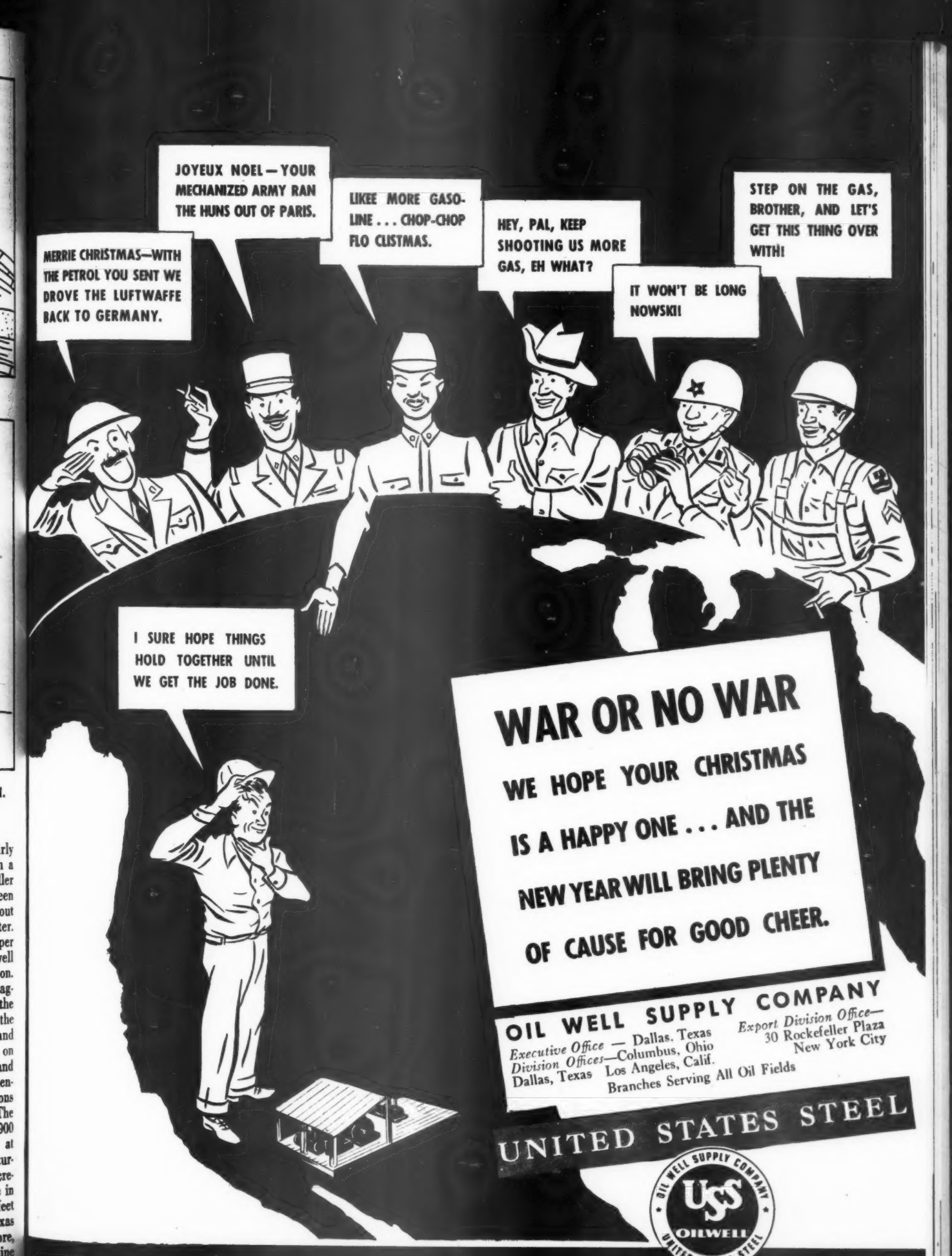


Fig. 37. Barrel filled with oil and water pressure connected to bottom of barrel.

The reservoir is continuously interconnected except on the east edge and an abnormal area in the south end that produced only gas. The gas area has been explained as a function of the permeability rather than an isolated field.

A study of the porosity of the sand showed a slight decrease of porosity from the north to the south as well as a slight decrease in grain size. The average porosity of the field is about 25.2 per cent. The permeability ranges from zero for the fine grained and cemented ash sands to 5000 millidarcies in coarse grained clean sand. The average sand has a permeability of 2000 to 3000 millidarcies. The average grain size is fairly continuous throughout the field with a tendency for the grain size to be smaller from the north to the south. It has been reported that the sand contains about 17 per cent interstitial connate water. When the connate water exceeds 30 per cent in a section of the sand the well produces some water from that section.

With the Woodbine formation averaging some 65 ft. in thickness above the —3322.5-ft. level (water level) in the East Texas field, the oil saturated sand section is estimated at average 37.5 ft. on the basis of well logs, core records, and electrical surveys, except the new extensions in which the oil saturated sections will not average more than 10 ft. The original area of the field being 127,000 acres and the extensions estimated at 13,000 acres, the total volume of saturated sand is estimated at 4,890,000 acre-feet, of which 4,760,000 acre-feet are in the original field and 130,000 acre-feet are in the extensions. In the East Texas field there is no free gas, and therefore, all available pore space in the Woodbine sand, situated above the water level, is filled with oil and with gas in solution. The present proved area of the field,


MERRIE CHRISTMAS—WITH THE PETROL YOU SENT WE DROVE THE LUFTWAFFE BACK TO GERMANY.
JOYEUX NOEL—YOUR MECHANIZED ARMY RAN THE HUNS OUT OF PARIS.
LIKEE MORE GASO-LINE . . . CHOP-CHOP FLO CLISTMAS.
HEY, PAL, KEEP SHOOTING US MORE GAS, EH WHAT?
IT WON'T BE LONG NOWSKI!
STEP ON THE GAS, BROTHER, AND LET'S GET THIS THING OVER WITH!
I SURE HOPE THINGS HOLD TOGETHER UNTIL WE GET THE JOB DONE.
WAR OR NO WAR
WE HOPE YOUR CHRISTMAS IS A HAPPY ONE . . . AND THE NEW YEAR WILL BRING PLENTY OF CAUSE FOR GOOD CHEER.
OIL WELL SUPPLY COMPANY
Executive Office — Dallas, Texas
Division Offices—Columbus, Ohio
Dallas, Texas Los Angeles, Calif.
Branches Serving All Oil Fields
Export Division Office—
30 Rockefeller Plaza
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UNITED STATES STEEL
OIL WELL SUPPLY COMPANY
USS
OILWELL
UNITED STATES STEEL
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with Woodbine sand porosity equal to 25 per cent, and completely saturated, carries under the original reservoir conditions 1940 bbl. of oil per acre-ft., or a total of 9,230,000,000 bbl., and the extensions with less favorable sand conditions, contain 150,000,000 bbl., or a total for the field of 9,380,000,000 bbl. (These figures are not accepted by all engineers and even if they were accepted they would have to be corrected for the interstitial water and the shale in the sand section. Another estimate of the original barrels in place is 5,793,000,000 when the shale and water are taken into account.) With a conservative producing rate and proper use of the water drive, 60 per cent recovery, of oil may be expected, which will mean production of 5,625,000,000 bbl. of crude oil and gas under reservoir conditions, or a net recovery of 4,507,900,000 bbl. of crude oil, after 20 per cent shrinkage to atmospheric conditions, indicating a probable recovery of 932 bbl. of crude oil per acre-foot and an average production of 35,000 bbl. per acre within the present boundaries of the field. Using the more conservative figures with 75 per cent recovery, which is nearer to the generally accepted figure, the recovery will be 4,344,750,000 bbl. of oil at reservoir conditions. This figure corrected to atmospheric conditions will give 3,475,800,000 bbl. of oil.

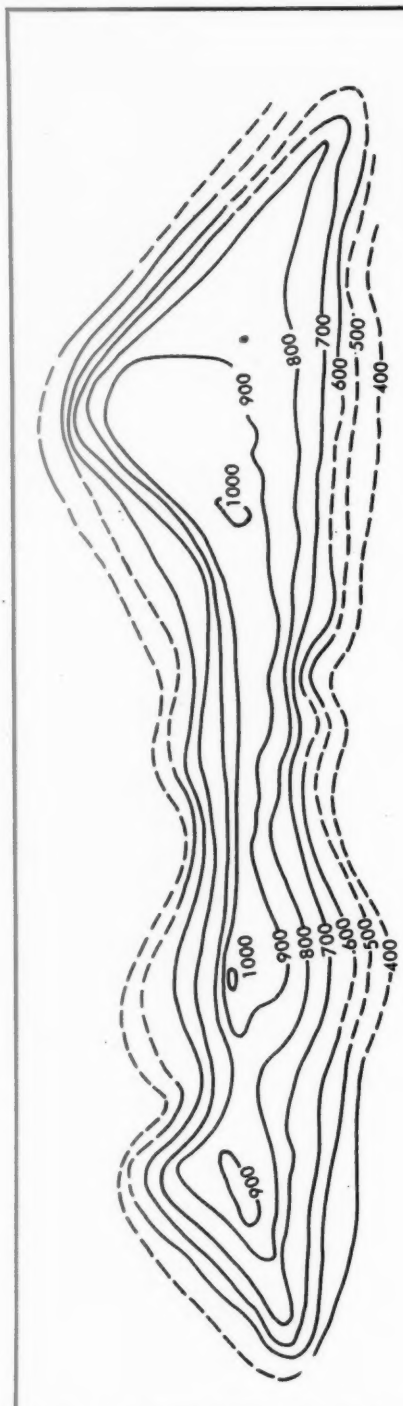

Fig. 38. Potential map of East Texas.
Barrels per hour
In effect prior to January 31, 1936
Total wells—19,700
Marginal wells—8,263
Hourly potential—14,627,235 bbl.
Daily allowance—486,111 (2.70%)

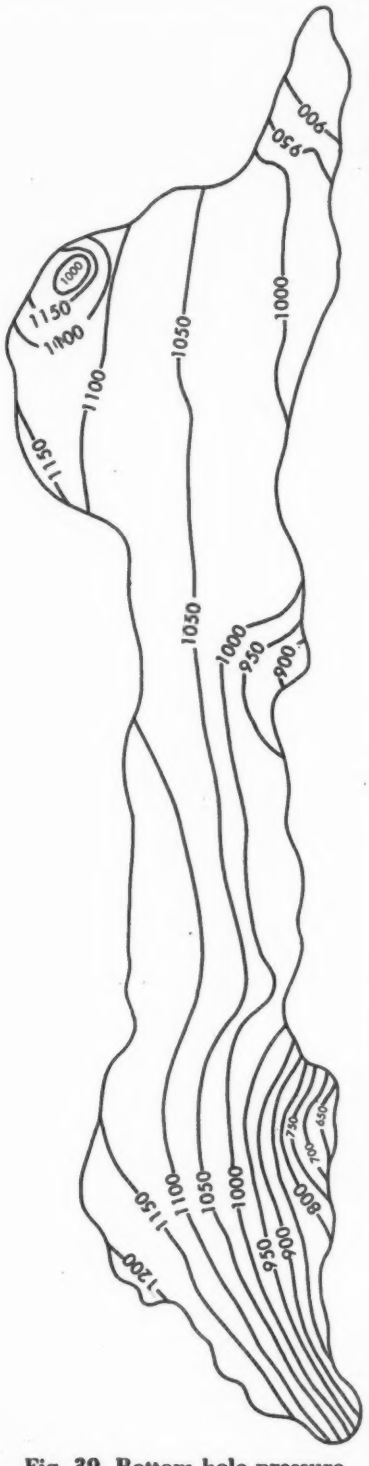

Fig. 39. Bottom hole pressure.
Map of East Texas oil field
November 1, 1941
Average pressure 1050.46

Here are a few basic facts generally accepted on the East Texas field that influence the performance the field will give:

a. Woodbine sand is producing in the field from a huge gently westward dipping monocline type structure, truncated on the east side and effectively sealed by the Austin chalk, which rests unconformably on the producing sand. The west dip on top of the Woodbine sand is very gentle. The dip is 50 ft. per mile in the central Kilgore section and 25 ft. per mile in north Longview sector.

b. The Woodbine sand is unusually permeable and remarkably uniform throughout the field as is shown by the cores, electric logs, and production records, and in a few areas where tighter zones are present their effectiveness in dividing the field into separate sectors has long ago been overcome by the great number of completions with perforated liners or screens. That such is actually the case is further substantiated by the behavior of the reservoir pressures, which are very uniform in the field and in the past have built up very fast after brief field shutdowns.

The oil saturated portion of the Woodbine sand lies between—3100-ft. level on the east side of the field, where the sand pinches out, and —3322.5-ft. level on the west side at which the salt water table was originally found. On the north side of the field in a very limited area where production is derived from a secondary sand body that is lenticular, separate from the main reservoir, the water table has been found to be at —3355 ft. or 22.5 ft. below the water table of the field proper.

The original bottom hole pressure of the reservoir was around 1620 lb. per sq. in. and the temperature of the reservoir is 143° F.

There is no free gas in the East Texas Woodbine reservoir except a very limited and apparently separated area on the south end of the field. Gas solubility tests indicate that 365 cu. ft. of gas are released from the crude oil at 90 °F. in decline from 740 lb. to atmospheric pressure. The attendant shrinkage of the oil, which totals around 20 per cent in East Texas, is due to liberation of dissolved gas 16.0 to 16.5 per cent, and to thermal contraction in lifting the crude from the reservoir to the surface temperature, 3.5 to 4.0 per cent.

Oil compressibility tests, conducted by Lindsly, indicate that the East Texas reservoir volume expanded approximately 4 per cent from its original pressure to 1200. Lindsly accordingly estimates that possibly 4 per cent of the oil produced in the East Texas field when the pressure was 1200 lb. had been due to

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the expansion of crude oil in the reservoir.

The Woodbine sand throughout the extent in northeast Texas is filled with salt water at pressures very closely representative of the hydrostatic head to the outcrop and the sand itself is very uniform in its permeability and porosity. Schilthuis and Hurst have estimated that the entire basin contains approximately 4,000,000,000,000 bbl. of water. Water drive is the primary driving force in all Woodbine sand fields of the northeast Texas area and it has been responsible for the unusually high percentage of recovery. Due to the very gentle dip about half of the reservoir is actually underlain by water, which together with reasonable withdrawals from the pool, renders the water drive particularly effective.

There are but two natural methods by which water may move into the East Texas fields as oil is produced. The first possibility is that water enters the Woodbine formation at its outcrop and flows through the entire sand body to the reservoir. The second possibility is that the flow of water is supplied by virtue of the expansive power of the water contained in the Woodbine sand. Consideration of the first method has shown that the flow of water through the sand over the great distance between the outcrop and the oil reservoir would entail such friction loss, and hence such large pressure drops that the water could not be supplied at the required rate under the existing pressure in the East Texas field. Concerning the second possible method, it would probably be concluded at first thought that the effect of the slight expansibility of water would be negligible; however, when the expansion of the tremendous quantities of water contained in the vast expanse of Woodbine sand is considered, relative to the quantities of water moving into the East Texas field, it is realized that the effect is important and must certainly be taken into account. The Woodbine sand contains roughly four trillion barrels of water. It is estimated that, if the pressure on such an enormous quantity of water were lowered by only 50 lb. per sq. in., it would expand and supply enough excess water to fill the space vacated by all oil produced from the East Texas field up to 1944. This example is given only to illustrate the magnitude of the amount of excess water that can be supplied by the expansion of so large a body of water as is contained in the Woodbine sand.

The mechanism by which water flows into the East Texas field, on account of its expansibility, is as follows: When production first began, the pressure in the reservoir and on the water adjacent to the oil body on the west was lowered. This allowed the water to expand and drive oil eastward to fill space vacated by oil produced. As production has continued, the pressures have been progressively lowered and the water has been caused to flow toward the field from greater and greater distances out in the Woodbine sand. This type of flow is essentially the same as that by which oil and gas flow to a well bore from the surrounding formation when the pressure at the well is lowered.

New method found to exclude salt water

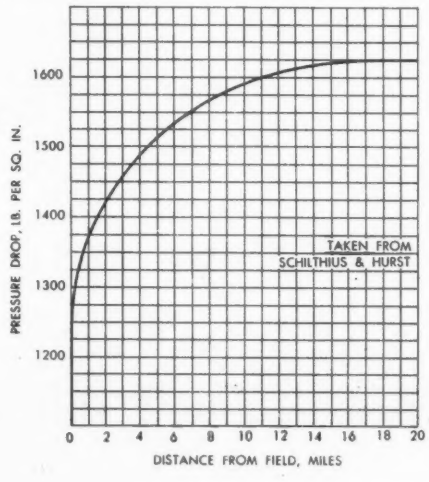
A new process to aid in exclusion of salt water from oil wells, developed by Dr. Eugene A. Stephenson, will be turned over to the public by the recently incorporated University of Kansas Research Foundation. Dr. Stephenson, executive director of the foundation, said that he has donated all rights as patentee to the research group, and that organization has taken steps to make the method available to the oil industry.

The process provides for the exclusion of water from oil wells by injection of oil into the water-bearing section of the producing formation. Phillips, Cities Service, and Stanolind companies, which aided in financing the new plan, have licenses to use the process, but have assigned all rights except shop rights to the research foundation.

P. T. Amstutz, Jr., now with the Standard Oil Company of Ohio, assisted Dr. Stephenson in directing research leading to the new process.

The pressure of the East Texas field as previously discussed was the average pressure of the field. It must be remembered that a pressure gradient exists across the field from east to west. The higher pressures are on the west and the lower pressures are on the east. Refer to the accompanying bottom hole pressure map for an approximate picture of pressure conditions existing in the field in November, 1941. Note that the isobars (lines of equal pressure) run north and south. Poor sand conditions along the north edge of the field account for the fact that the isobars do not more closely follow the structural contours in that area. The pressure gradient across the field is a natural result of the water drive from the west. Reservoirs acting under gas cap drive have the highest pressures in the gas cap area and lower pressures down structure in the oil column. If a sand were perfectly uniform, the wells evenly spaced, and an equal withdrawal rate per well maintained, the isobars would very closely follow the trend of the structure. It will be noted that a much greater gradient exists across the south end of the East Texas field than in other areas. This is due largely to poorer sand development in that area with the consequent greater resistance offered to the flow of fluids and resulting transmission of pressure. Although wells are not available for the measurement of pressures beyond the edge of the field, the gradient extends on out into the basin. Inasmuch as fluids flow from areas of high pressure to areas of low pressure, the gradient would show the flow of water into the field and the regional migration of oil and water from west to east. The pressure at various distances from the field in August, 1934, were calculated by Schilthius and Hurst and are shown in an accompanying graph. Notice that the pressures were not believed to be reduced more than 20 miles from the field at that time.

Fig. 40. Calculated pressure distribution West of East Texas field, August, 1934.

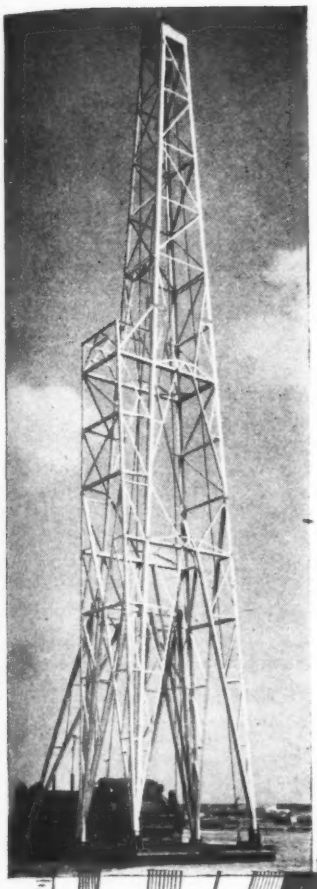


During periods of high withdrawals the pressure gradient across the field increases and during shut-in periods or periods of relatively low withdrawals the gradient is diminished. If the field were to be shut in for a sufficient time the pressure would become uniform throughout the field at or near the original pressure of approximately 1620 lb. per sq. in.

That a pressure gradient exists across the field and that there is a uniform pressure arrangement shows not only the effects of the water drive but demonstrates the fact that the entire field is a common reservoir.

The pressure of the East Texas field is important for many reasons. If the pressure is kept high by avoiding an excessive production rate either through prevention of water production or through return of water to the sand, a greater portion of the oil can be produced from flowing wells. Data have been accumulated to show that flooding efficiency may be decreased as much as 25 per cent if the reservoir pressure is allowed to fall below the saturation pressure before the advance of the water. If the pressure is allowed to fall below the saturation pressure, gas will come out of solution in the sand. Wells on the east side where the pressure will be lowest will produce with high gas-oil ratios. The oil left in the sand after release of the gas will have a higher surface tension and be more viscous than normal reservoir oil thus requiring a greater pressure differential to move it into the wells. Viscosity data by Ben Lindsly show that the viscosity of East Texas crude with its dissolved gas at reservoir temperature, is 0.93 centipoise, whereas the viscosity at the same temperature after the

Someone else can "follow THE LEADER"

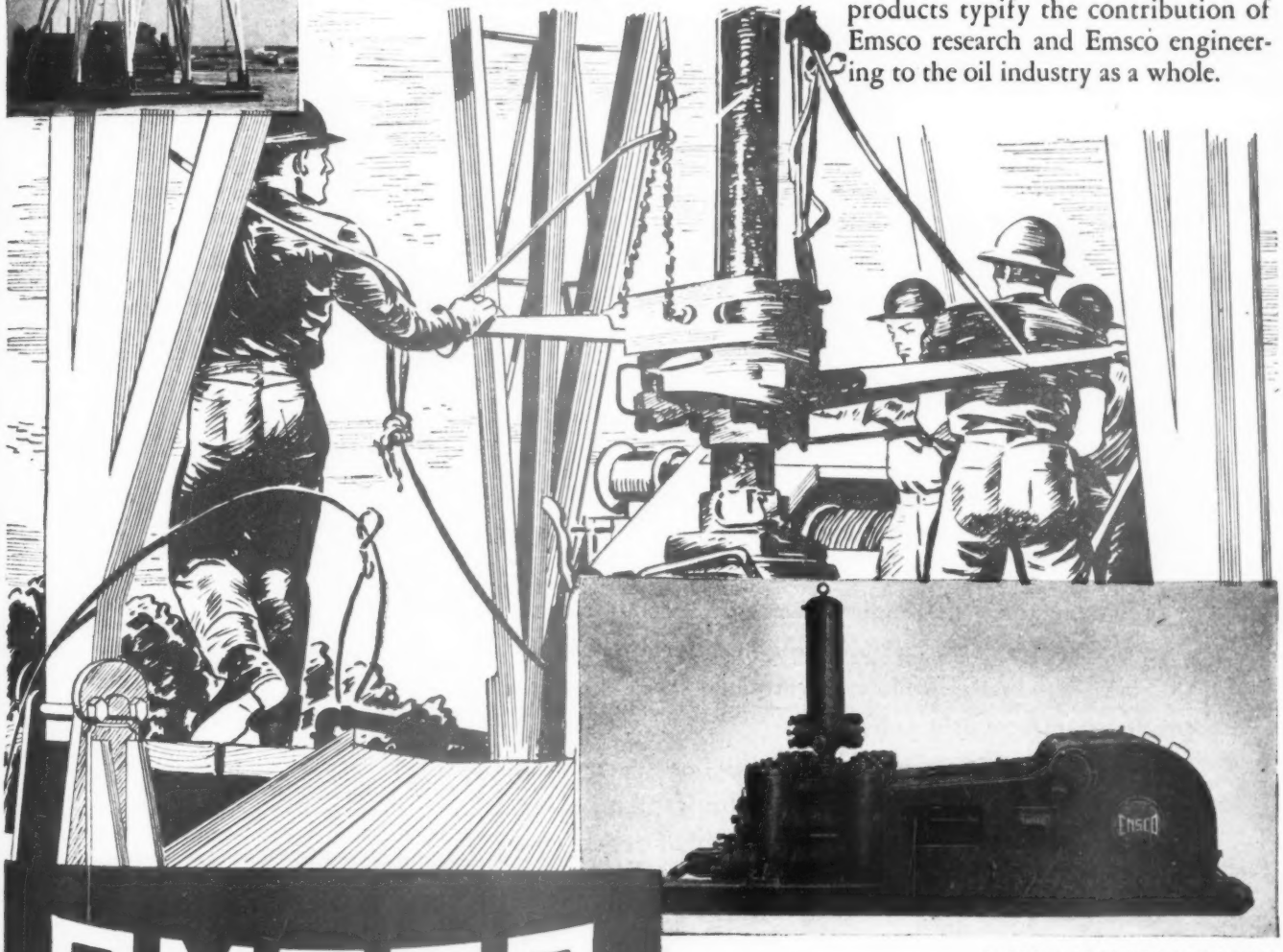


It's all right to play "follow the leader" and merely keep your products abreast of the latest engineering developments. There's more satisfaction, however, in keeping ahead of the crowd—out in front—being the leader. That, in a nutshell, is the basis for Emsco's continual progress in developing better oil field drilling equipment.

Emsco has always placed particular emphasis on their Engineering and Research Departments. It is here, on the drafting boards and in the laboratories, that the future of the oil industry lies. The men and the women in these departments must anticipate trends and translate these trends in terms of efficient oil field equipment.

The two products illustrated on this page, the Emsco 12-P Portable Mast and the Emsco A-10 Triplex Slush Pump, have features developed by our Research and Engineering Departments to meet long felt needs in drilling practice. They represent the latest design in equipment of this type. Both products typify the contribution of Emsco research and Emsco engineering to the oil industry as a whole.

Left—EMSCO 12-P PORTABLE MAST



EMSCO A-10 TRIPLEX SLUSH PUMP

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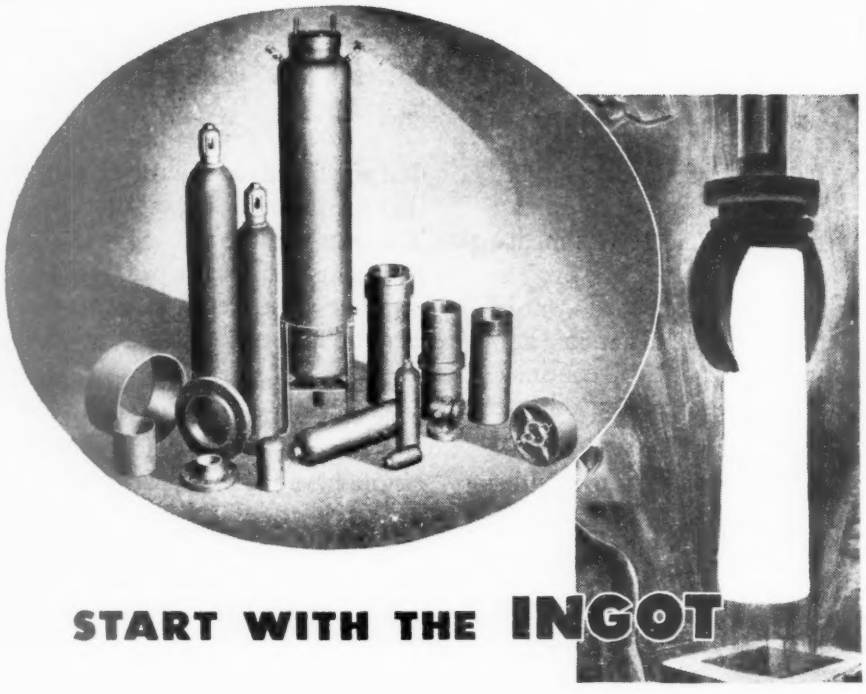

START WITH THE INGOT

The true beginning of any man-made article is in the brain of its designer, inventor or creator. Harrisburg Steel is like that. Our engineers, chemists and draftsmen are continually at work on new formulas, designs and machines which may improve even our world-wide reputation for building seamless and drop-forged steel products to specification.

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gas has escaped from solution is 1.86 centipoise or exactly twice as great. The economic importance of retaining the field pressure above the saturation point cannot be overemphasized.

Tables in previous installments of this series have shown the oil production rates and water production rates for various periods in the field's history. The general bottom hole pressure trend is shown by the following table:

Bottom hole pressures measured by Railroad Commission:

Date	Avg. pressure at 3300 ft., lb. per sq. in.
June, 1933	1240
January, 1934	1274
January, 1935	1246
January, 1936	1201
January, 1937	1176
January, 1938	1120
June, 1938	1116
January, 1939	1107
June, 1939	1086
January, 1940	1061
June, 1940	1056
January, 1941	1052
June, 1941	1042
January, 1942	1026
March, 1942	1008
June, 1942	1032
January, 1943	1016
June, 1943	1017
January, 1944	1012
April, 1944	1008

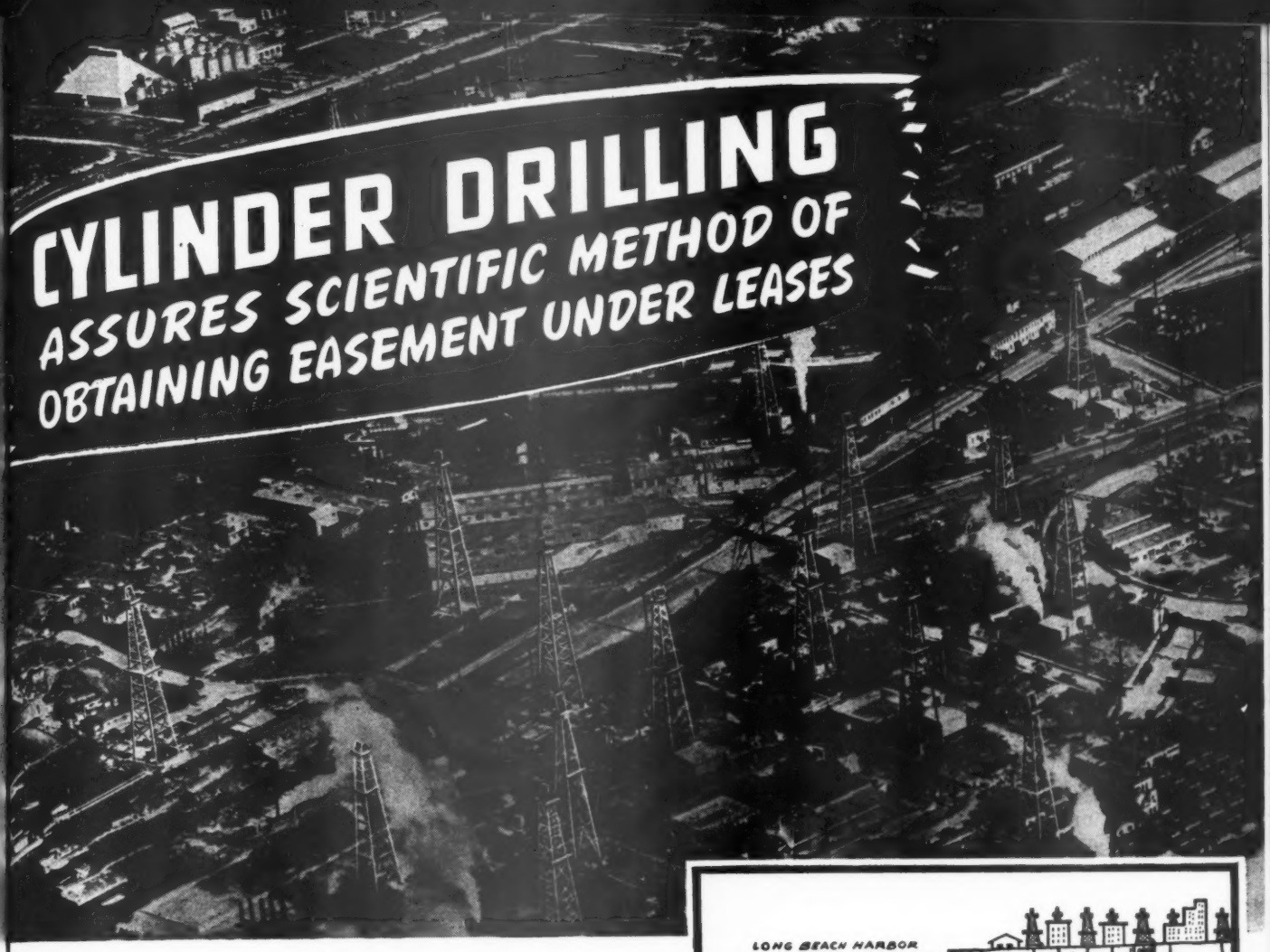
The salt water injection program contributed largely to the low rate of decline in 1943 and the early part of 1944, even though increased demands caused increased oil production rates, and large volumes of salt were being produced. Approximate salt water injection rates in barrels per day are tabulated below. The table clearly indicates the rapid expansion of water injection after the formation of the disposal company.

Date	Approximate avg. daily water injection, bbl.
January, 1939	2,000
January, 1940	19,000
January, 1941	52,000
January, 1942	80,000
January, 1943	102,000
January, 1944	312,000
February, 1944	325,000

▶ **Induced water drive.** We have discussed natural water drive in detail and studied the natural requirements for an effective water drive. As water drive is the most effective method of oil production, every effort should be made to operate under water drive conditions. In many fields the natural water drive is not sufficiently effective to allow production under water drive conditions, if the oil is to be recovered during a reasonably short period of time, and in many reservoirs no natural water drive is present. In order to obtain the greatest possible oil recovery these fields can be produced by "induced" or artificial water drive. For the greatest efficiency and least cost the water injection should begin early in the life of the field while the reservoir pressure is high, rather than after the field is nearly depleted as in most "water flood" projects of the past. ★ ★ ★

(To be continued)

CYLINDER DRILLING ASSURES SCIENTIFIC METHOD OF OBTAINING EASEMENT UNDER LEASES



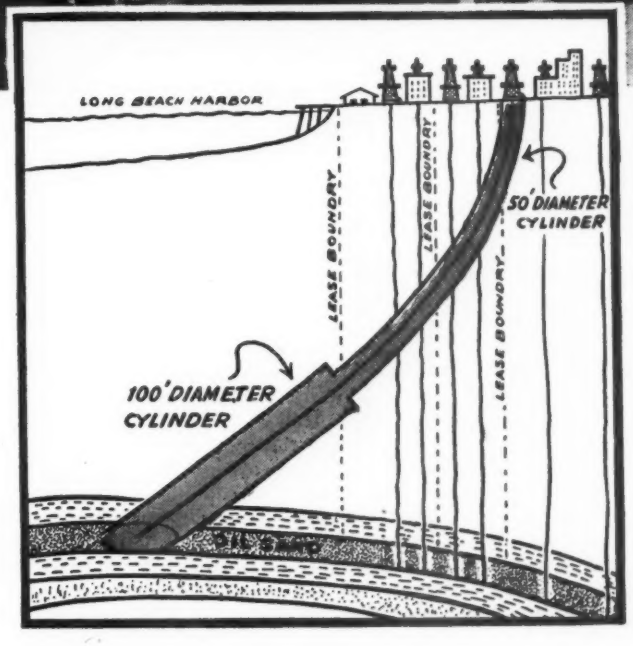
iew of oil development in
ong Beach Harbor area.

Photo courtesy the Inman Company

OVER 128 "CYLINDER DRILLED" DIRECTIONAL WELLS COMPLETED WITH HORIZONTAL DEFLECTION . . .
Totaling 241,128 Feet

When oil horizons underlying oceans, rivers, harbors, etc., are developed through wells directionally drilled from the shore, the surface location frequently falls in congested areas such as that surrounding Long Beach Harbor in the scene above, and must necessarily be some distance from the edge of the water. The directional well, therefore, must cross one or more leases before reaching the lease under which it is to be bottomed.

An easement, or right-of-way, in the form of a cylinder, curving out to the well's bottom hole location, is secured from the intervening lease holders. When passing previously completed vertical wells or crossing other leases, the cylinder diameter is usually held to fifty feet, but as the well leaves the congested area, the cylinder diameter is increased to one hundred feet. Great skill and accuracy are required of the Directional Drilling Engineer, who must drill his well as close to the axis of the cylinder shaped easement as possible.



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OPERATION OF CENTRAL GAS PLANT AT TORRANCE REFINERY

By **RANDALL MAASS,** General Petroleum Corporation of California

THERE have been times when sufficient normal butane was available so that the sale of LPG has been limited by the available propane. Under such conditions, the value of propane is enhanced to such an extent that additional efforts can be made to increase its extraction. At the present time large portions of the normal butane supplies are being used for the manufacture of butadiene, for isomerization to isobutane, and for supplying volatility to the heavy gasoline stock now used for motor fuel. With the normal butane thus diverted, sufficient propane is readily available for blending with the limited amount of normal butane allotted to LPG sales and no unusual efforts need be made to increase its extraction. It may be possible to increase this propane demand somewhat by developing the market for pure propane fuel.

In the treatment of refinery gases, the presence of valuable unsaturates makes high extractions economically attractive because of the recovery of these components. That is, if a high propene extraction is sought, a high propane extraction is a natural result. At our Torrance refinery we have installed, in connection with our 100-octane plant, an 11,000,000 cu. ft. per day gas plant designed to handle vapors from the entire refinery. For the first several months of its operation only a portion of its 600 gal. per min. oil circulation capacity was needed to meet design extractions. The excess capacity was therefore used to increase extractions above design. The results of these operations are being presented with the hope that they may be of some benefit in the event you should again desire a high propane extraction.

*Presented at California Natural Gasoline Association monthly meeting, August 6, 1944.

In addition, this paper will perhaps show the contrast as well as the similarities in the handling of refinery vapors as compared to natural gases.

▶ **Results obtained at the gas plant.** The results we have obtained at our central gas plant are plotted in Curve I. In this curve the percentage extractions for the various components are plotted against the absorption factors. The solid curve

Results of operations to obtain propane extractions in excess of design — comparisons in handling refinery vapors and natural gases.

is the operating line representing the overall plant extraction; whereas, the dotted curve represents the extractions obtainable for a single four theoretical plate absorption. Looking at the points that represent the propane extraction we see that they range from well above 80 per cent down to almost 60 per cent. The gradually decreasing extraction is a result of an increasing load at the absorption plant.

The gas plant began operating in October, 1943. Being the first of the new 100-octane units to be started, it operated only on the vapors from the old refinery; that is, from the visbreaker, reformer, and straight run units, which amount to about 4,000,000 cu. ft. per day. The alkylation unit was placed in operation in January, 1944; however, this unit contributes less than 500,000 cu. ft. per day. Two TCC units were placed in operation in March, 1944, which added 3,500,000 cu. ft. per day. The last of the four TCC units has just been placed in operation and the total TCC gas now amounts to 7,000,000 cu. ft. per day, bringing the total to the gas plant to about 11,000,000 cu. ft. per day. At times this volume may increase to 13,000,000 cu. ft. per day. As three or four million of this volume is low pressure gas and goes directly to the low pressure absorber, a large proportion, that is about 70 per cent, of the oil circulation is used at the low pressure absorber. To reduce this demand we are making use of some compressor capacity that is available a large part of the time to compress this low pressure gas for high pressure absorption. Thereby we hope to again approach 80 per cent propane extraction. Eventually compressor capacity will be available for the full time compression of this low pressure gas.

Curve I also shows the average extractions obtained from October, 1943, through April, 1944. It will be noted that average propane extraction was 76.5 per cent and the isobutane extraction 97.8 per cent. Curve I has also been used to determine what our extractions will be on the average when we again attain

TABLE 2
Absorber operating conditions of refinery gas plant
80 per cent propane extraction

	High pressure absorber	Low pressure absorber
Pressure	120 lb.	35 lb.
Temperatures		
Lean oil	75°F.	75°F.
Top intercooler, in/out	85°F./80°F.	....
Bottom intercooler, in/out	83°F./80°F.	82°F./80°F.
Bottom tray	100°F.	90°F.
Rates		
Wet gas	11,600,000 cu. ft. per day	1,690,000 cu. ft. per day
Dry gas	7,200,000 cu. ft. per day	630,000 cu. ft. per day
Lean oil	380 gal. per min.	120 gal. per min.
Lean oil/dry gas	76 gal. per M. cu. ft.	270 gal. per M. cu. ft.
Propane abs. factor	1.21	1.21

TABLE 1
Wet gas and products of refinery gas plant
80 per cent propane extraction

Constituent	Wet gas, mol. per cent	Absorption factor	Per cent extracted	Extract liq., per cent	Dry gas, mol. per cent
Hydrogen	19.6		0		27.6
Nitrogen	3.1		0		4.3
Methane	29.7	0.044	0		41.6
Ethene	3.1	0.24	0		4.3
Hydrogen sulphide	2.2	0.355	7.5	0.3	2.9
Ethane	10.0	0.37	9.3	2.7	12.7
Propene	6.7	1.03	72.7	15.0	2.6
Propane	13.9	1.21	80.0	36.7	3.9
Isobutane	4.1	2.93	98.4	15.8	0.09
Butenes	3.2	4.07	99.7	11.5	0.01
N-butane	2.7	4.07	99.7	10.4	0.01
Isopentane	0.4	11.0	100.0	1.9	
Pentenes	0.6	14.4	100.0	2.6	
N-pentane	0.7	14.4	100.0	3.1	
Total	100.0			100.0	100.0
Volume	11,000,000 cu. ft. per day.		90,760 gal. per day.		7,830,000 cu. ft. per day.

TABLE 3
Rich oil fractionator operating conditions of refinery gas plant
80 per cent propane extraction

Reflux accumulator pressure	115 lb.	Lean oil Gravity 45° A.P.I.
Tower pressure	120 lb.	Initial 275°F.
Feed rate	680 gal. per min.	10% 280°F.
Top product rate	80 gal. per min.	50% 320°F.
Reflux rate	160 gal. per min.	90% 370°F. E.P. 450°F.
Reflux ratio	2/1	V.P. 10 mm. of Hg. at 100°F.
Top temperature	200°F.	
Bottom temperature	520°F.	
Bottoms circulation	500 gal. per min.	
Heat Load	20 M³ B.t.u. per hr.	

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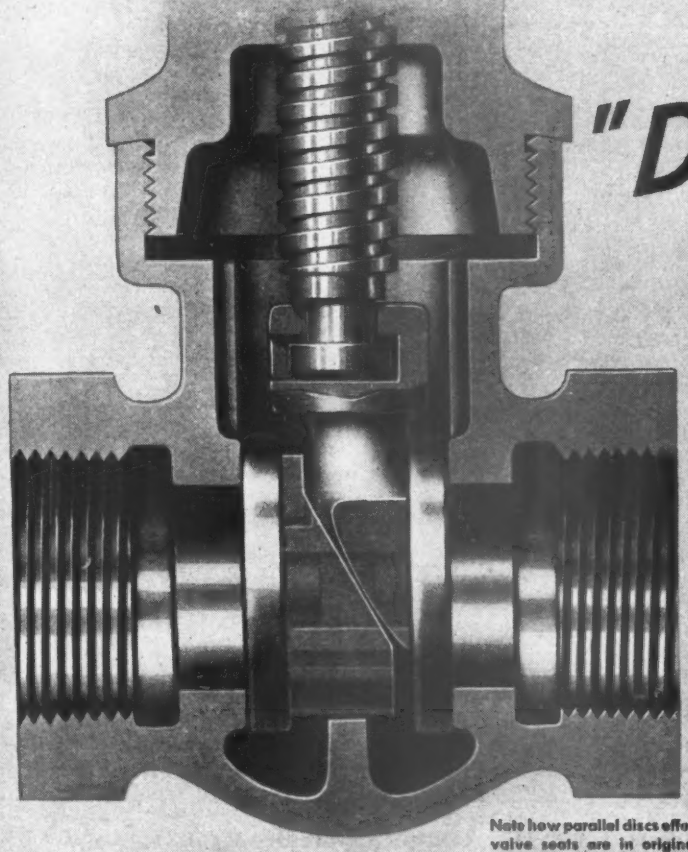
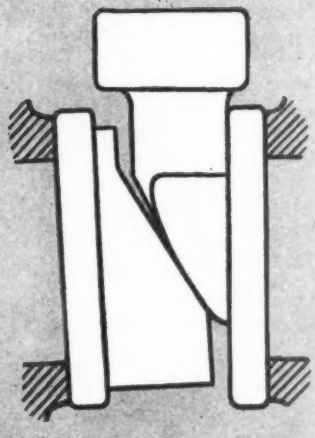


Note how parallel discs effect tight closure when valve seats are in original parallel position.



This greatly exaggerated diagram shows how the curved face of the upper wedge allows the discs to fit against seats, "unparalleled" by valve body distortion.

Darling manufactures a quality line of gate valves for long service—in parallel seat or tapered seat—slotted or solid wedge types—for service pressures up to 3000 pounds. Valves are available in cast iron, bronze, cast steel, forged steel, corrosion resisting and special alloys. Darling also manufactures check valves, compression type fire hydrants, motor and cylinder operated valves, and accessories.

THERE is one gate valve design that insures "drop-tight" seating, year after year. It is the unique Darling design. Darling's fully revolving double disc parallel seat gate valve provides:

1. ADAPTABILITY—Any valve can close tight the day before it is installed. But the day after is another story. Pipe out of alignment and bolting strains distort valve bodies. Pressure and temperature changes and other operating strains force valve bodies out of shape, too, so that gate and seats do not remain parallel.

To compensate for "unparalleled" seats, in the Darling valve wedging assembly a straight or tangent surface on the lower wedge acts on a curved or "radius" surface on the upper wedge. So no matter what position valve seats reach in years of usage, the Darling twin discs make perfect closures.

2. UNIFORM WEAR—The twin discs are free to revolve 360°, seating in a different position each time the valve is operated. Wear on discs and seats is uniform, making possible tight closing year after year.

3. INSTANT RELEASE—The four simple parts of the valve assembly—two discs, two wedges—release at the first fractional turn of the stem to open. The gate is immediately free to rise with little or no friction.

For over 40 years engineers have found that Darling Valves give "drop-tight" shut-off, long life and low maintenance.

NOW—when maximum uninterrupted production is all-important—you can safeguard it by installing Darling Valves. Later, when low-cost operation and maintenance are vital, you will be all set with valves that help you keep costs down and help you compete in postwar markets.

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80 per cent propane extraction. These extractions are tabulated in Table I. For a propane extraction of 80 per cent we will obtain an isobutane extraction of 98.4 per cent, which is materially above the design estimate of 94 per cent. Constituents heavier than isobutane for all practical purposes are completely absorbed. Along with the propane, we will extract about 73 per cent of the propene in the gas with relatively small amounts of ethane and hydrogen sulphide. To obtain these extractions it is necessary with our process to use a propane factor of 1.21, which corresponds to a normal butane absorption factor of 4.07. These factors are considerably higher than normally employed in gas absorption plants.

The type of gas we handle contains about 20 per cent hydrogen, 3 per cent nitrogen, and 30 per cent methane. The total ethane and lighter content of our wet gas runs about 68 per cent, which is not too far removed from the type of wet gas treated in natural gas plants. The extract, however, is made up of principally C_3 and C_4 compounds. The C_5 content is about 7½ per cent with no appreciable hexanes and heavier. The dry gas, because of its high hydrogen content, has a heating value in the neighborhood of the familiar 1100 B.t.u./ft.³

▶ **Process.** The process used in obtaining the above extractions is diagrammatically illustrated in Fig. 1. The plant is a standard two-stage absorption plant

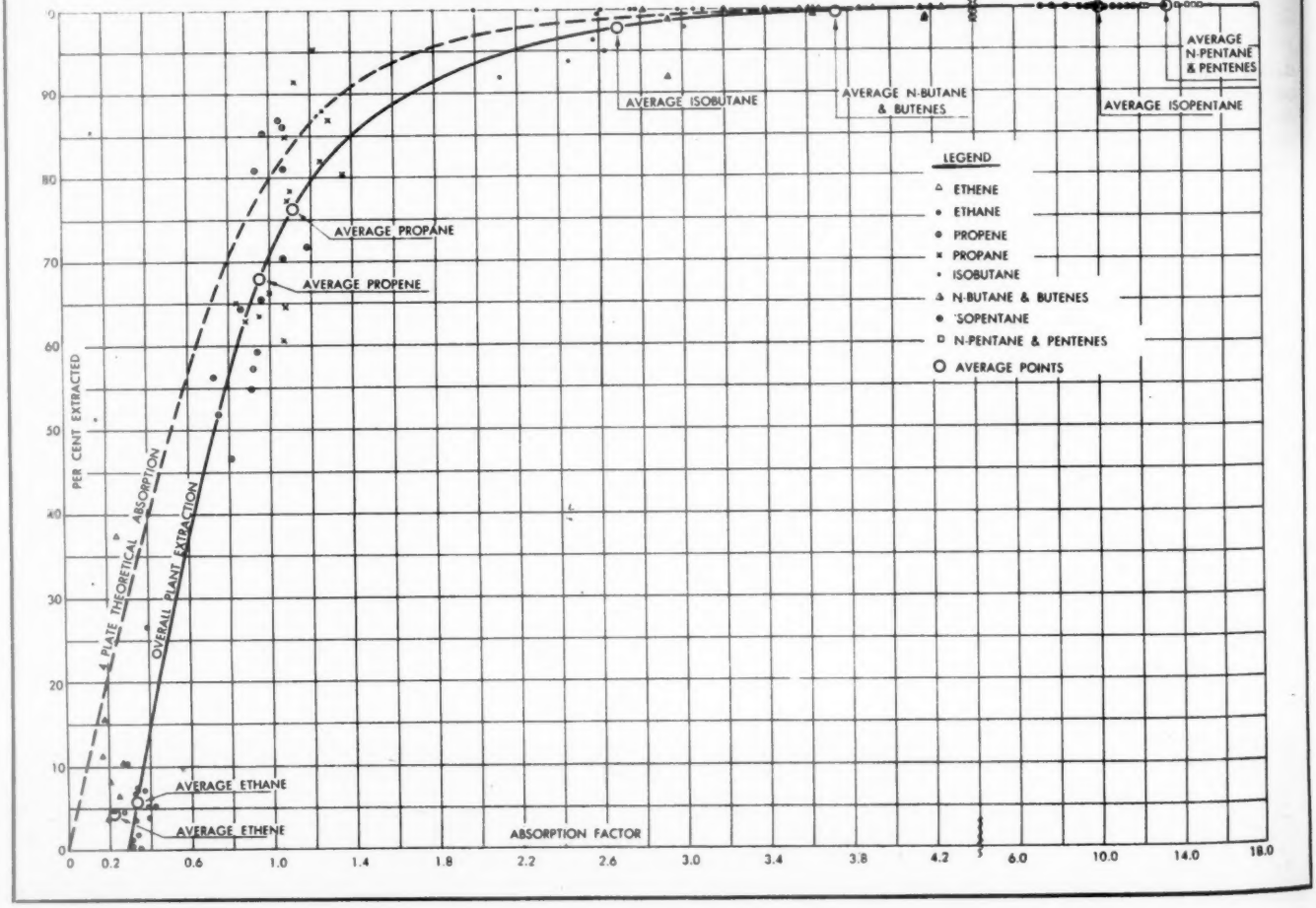
TABLE 4
Intermediate flashes, refinery gas plant
80 per cent propane extraction

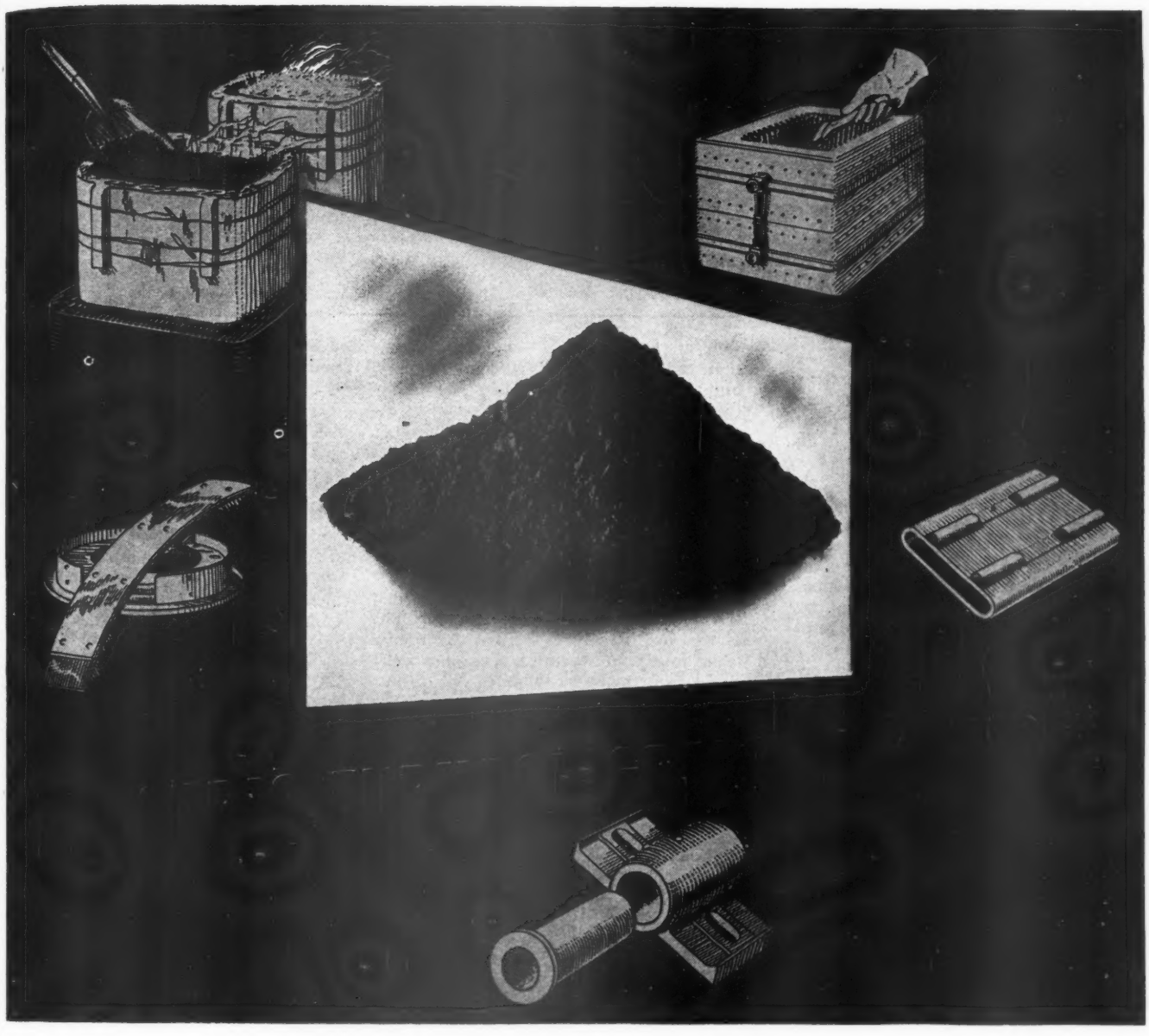
Constituent	L. P. absorber flash vapors, mol. per cent	Rich oil vent flash vapors, mol. per cent	Reflux accumulator flash vapors, mol. per cent
Hydrogen	....	....	....
Nitrogen	....	....	....
Methane	15.2	4.5	0.8
Ethene	4.8	4.2	1.0
Hydrogen sulphide	4.7	4.3	3.0
Ethane	19.5	16.8	14.0
Propene	15.7	20.2	21.5
Propane	30.5	39.1	43.7
Isobutane	4.4	5.2	7.0
Butenes	2.7	2.8	4.6
N-butane	2.2	2.3	3.8
Isopentane	0.1	0.2	0.2
Pentenes	0.1	0.2	0.2
N-pentane	0.1	0.2	0.2
Total	100.0	100.0	100.0
Volume..... 790,000 cu. ft per day.	600,000 cu. ft. per day.	900,000 cu. ft. per day.	

TABLE 5
Refinery gas plant, tower summary

	High pressure absorber	Low pressure absorber	Rich oil fractionator	
			Rectifying section	Stripping section
Tower diameter	6 ft.	5 ft.	7 ft.	9 ft.-6 in.
Tower height	72 ft.	72 ft.	83 ft.	83 ft.
Design pressure	150 lb.	100 lb.	150 lb.	150 lb.
Number of trays	26	26	15	15
Tray spacing	2 ft.	2 ft.	2 ft.	2 ft.
Type tray	Single cross-flow	Single cross-flow	Single cross-flow	Double cross-flow
Intercooler boots	2	2		
Downflow area	2.7 sq. ft.	2.64 sq. ft.	4.35 sq. ft.	12.8 sq. ft.
Weir length	47 in.	44 in.	59 in.	162 in.

CURVE NO. 1. ABSORPTION CHARACTERISTICS OF THE TORRANCE REFINERY GAS PLANT.





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in which the rich oil from the 120-lb. high pressure absorber is flashed in the bottom of the 35-lb. low pressure absorber. The combined rich oil stream is vented at 15 lb. and the vent gas recycled via a compressor back to the high pressure absorber. The raw B-B extract and the lean oil are separated in a 30-plate rich oil fractionator using raw B-B as reflux and a forced circulation, direct-fired heater operated at 520 °F. as a reboiler. The reflux accumulator is operated at 115 lb. so as to retain all the C_3 and C_4 fractions. The uncondensed vapors from the reflux accumulator are cycled to the low pressure absorber.

The dry gas from this plant is used as refinery fuel. The raw B-B extract, together with the raw B-B from the other refinery units, is used as charge stock to the HF alkylation unit, after the C_3's and normal pentane and heavier have been removed.

TABLE 6

Wet gas and products, natural gas plant

77 per cent propane extraction

Constituent	Wet gas, mol. per cent	Absorption factor	Per cent extracted	Extract liq., per cent	Dry gas, mol. per cent
Carbon dioxide	1.4				2.1
Methane	58.6	0.045	0.1	0.1	85.2
Ethane	7.1	0.38	6.5	1.0	9.6
Propane	9.0	1.23	77.0	17.8	3.1
Isobutane	2.8	2.98	98.8	8.0	0.04
N-butane	5.6	4.13	100.0	16.2	
Pentanes plus	15.5		100.0	56.9	
Total	100.0			100.0	100.0
Volume.....	3,500,000 cu. ft. per day.		38,000 gal. per day.		2,400,000 cu. ft. per day.

▸ **Equipment design.** Table 5 lists the essential design features of the several towers in this plant. The high pressure absorber is a 6-ft. vessel with 26 single cross-flow bubble trays. In addition, the tower is provided with two boots to accommodate the removal and return of two intercooling streams placed one-third of the way and two-thirds of the way down the tower. These boots are a solid tray provided with a vapor chimney in the center. The intercooler pump takes suction at the inlet weir and discharges at the outlet weir. Diametrically across the center of the plate and parallel to the inlet and outlet weirs, a third weir is placed that is somewhat lower than the outlet weir. As the intercooler pump may circulate more or less than the downflow, this third weir provides a means of transferring fluid from the discharge section to the suction section, or vice versa, and yet tends to keep the hot and cold oil separated.

The low pressure absorber is a 5-ft. vessel also equipped with 26 single cross-flow bubble trays and provided with the two boots. This tower, however, is operated at present with intercooling at the lower position only. The results plotted in Curve I are therein compared to a four-plate theoretical absorption curve. Four theoretical plates out of 26 represent an efficiency of 15 per cent. This efficiency corresponds with that predicted from the correlation of Drickamer and Bradford[1] for our lean oil viscosity at operating conditions of one centipoise.

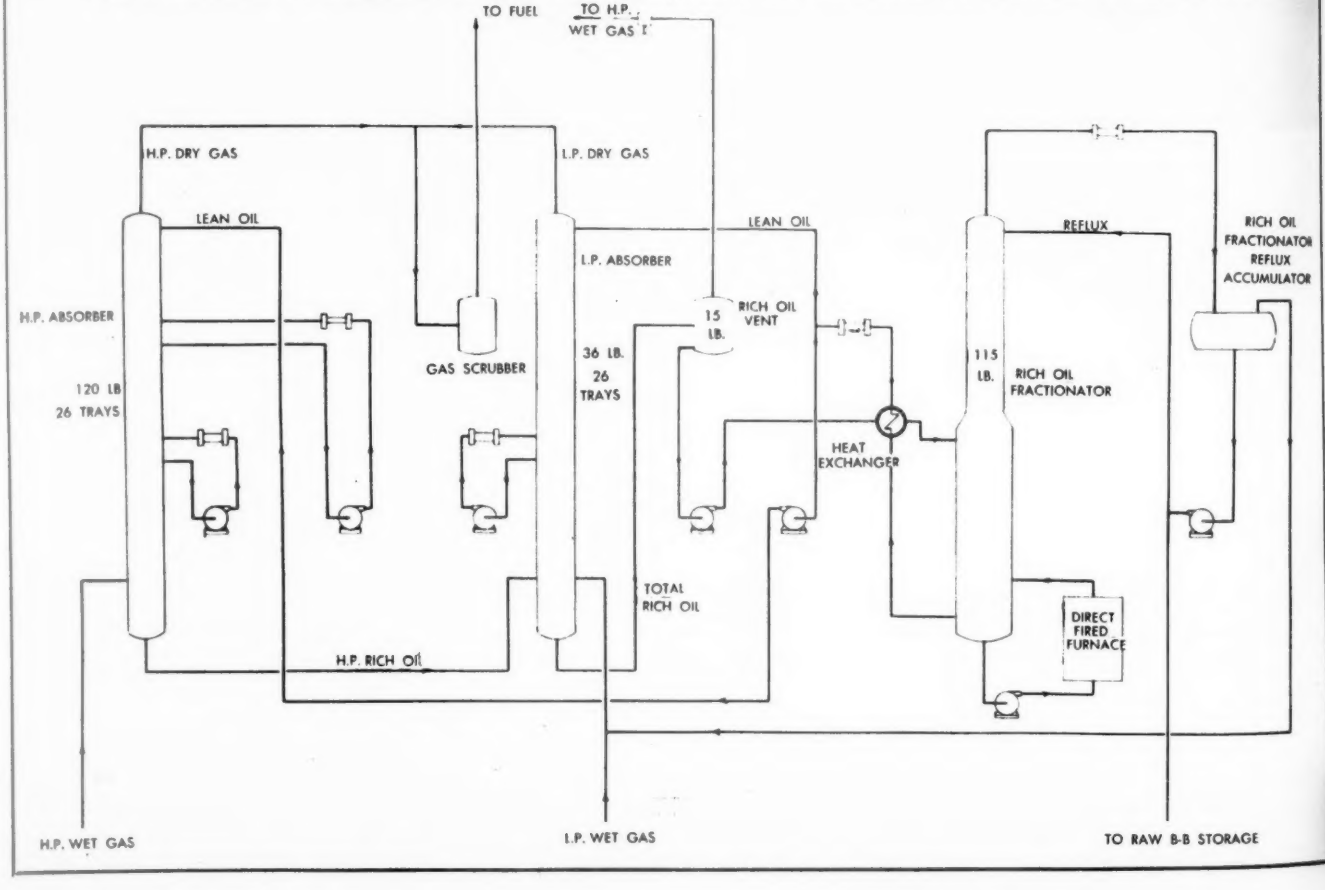
The rich oil fractionator has a 7-ft. rectifying section with 15 single cross-flow bubble trays. The stripping section is a 9-ft. 6-in. tower equipped with 15 double cross-flow bubble trays.

▸ **Operating conditions.** Table 2 lists the operating conditions that prevail at the high pressure and low pressure absorbers for an 80 per cent extraction. The 120-lb. high pressure absorber requires a lean oil to dry gas ratio of 76 gal. per M. cu. ft. in order to provide the required propane absorption factor of 1.21. The 35-lb. low pressure absorber requires a ratio of 270 gal. per M. cu. ft. for the same propane absorption factor. It will be noted that at these high oil rates the intercoolers provide only a relatively small amount of intercooling.

Table 3 lists the operating conditions for the rich oil fractionator under 80 per

[1]Drickamer and Bradford, "Overall Plate Efficiency of Commercial Fractionating Columns as a Function of Viscosity," *Petroleum Refiner*, Vol. 22, No. 10, 1943, pp. 105-110.

FIG. 1. SCHEMATIC DIAGRAM OF CENTRAL GAS PLANT OF GENERAL PETROLEUM CORPORATION.



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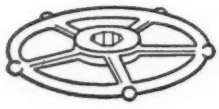

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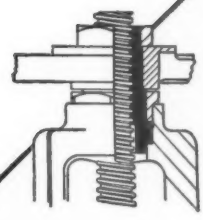

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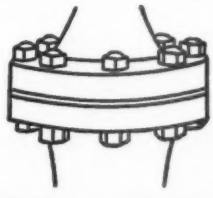

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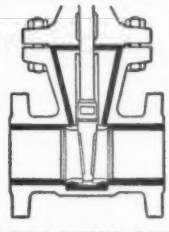

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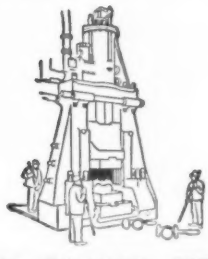

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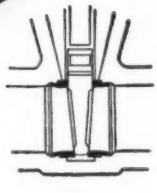

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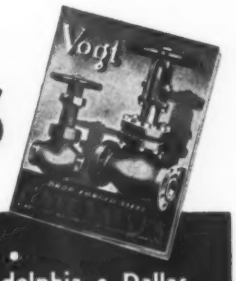

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cent propane extraction. The reflux accumulator is operated at 115 lb. and at about 80 °F. to 100 °F. The tower itself rides directly on the reflux accumulator pressure and the tower pressure runs approximately 120 lb. The tower is operated with a reflux ratio of about 2 to 1 on the top product. With a bottom temperature of 520 °F. the vapor pressure of the resulting lean oil is about 10 mm. of mercury at 100° F. This vapor pressure is somewhat higher than that normally desired for natural gas operations where the equilibrium oil loss in large dry gas volumes becomes appreciable.

In order to obtain the 520° F. at the bottom of the tower, the furnace outlet runs 550 °F., which is the maximum to which we wish to go in order to avoid any appreciable cracking. To obtain a lean oil vapor pressure of about 4 mm. of mercury the tower pressure with the bottom temperature held at 520° F., would have to be reduced to about 75 lb. This would be feasible in a natural gasoline plant with its lower vapor pressure extract. At our plant the high volatility of the extract requires a high operating pressure and the consequently high lean oil vapor pressure with its resultant small loss. The analyses of our dry gases, which are performed on a mass spectrometer, occasionally show traces of heavy ends.

Because of the higher pressures employed at the reflux accumulator and the rich oil vent tank the intermediate flash vapors are kept to a reasonable size. They are, however, sufficient to remove very effectively the greater portion of the ethane and lighter constituents from the extract. The volumes and compositions of the three plant flashes, that is, the low pressure absorber flash, the rich oil vent flash, and the reflux accumulator flash, are tabulated in Table 4. The deviation in Curve I of the plant extraction curve from the four theoretical plate extraction curve illustrates the effectiveness of these flashes in removing the light constituents from the extract. Of course some sacrifice is made in the propane and isobutane extract to attain these separations.

Application to natural gas extractions. This discussion has to some extent illustrated the similarity of refinery absorption plants and natural gas absorption plants. On the other hand you have perhaps gathered that the principal difference between the two rests on the fact that our extract is much more volatile than natural gasoline. Consequently, a high pressure level must be used in the flash system in order to retain the bulk of the extract while flashing off the undesirable light components. In natural gasoline plants where the extract can contain approximately 50 per cent pentanes and heavier, the flash pressures must be commensurately reduced in order to effect the removal of the light constituents.

Table 6 summarizes the results obtained in a natural gasoline plant that attained a 77 per cent propane extraction. This plant was of a design similar to the plant employed at the refinery and was operated similarly with the following exceptions:

The rich oil vent tank was operated at 5 lb. The gasoline-oil separator in this plant was a 35-lb. lean oil stripper equipped with a refluxing rectifying section. In addition, more than 50 per cent of the gasoline production was compression condensate, which was added to the system principally as reflux to the still.

The high propane extraction in this plant was made possible, despite the fact that the run-down accumulator was operated at only 35 lb., principally because of the heavy nature of the gasoline extract. This 77 per cent propane extraction showed an increase in yields of propane and heavier components of 2600 gal. per day above that obtained when aiming at about 47 per cent propane extraction.

For gasolines that are in the range between this heavy natural gasoline and the light refinery extract, high propane extraction may be obtained by increasing the pressure on the run-down accumulator and rich oil vent tank commensurate with the volatility of the product. This increased run-down accumulator pressure may be attained either by increasing the still pressure or by an after compression of the reflux accumulator vapors. ★★★

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DRILLING REQUIREMENTS BEFORE AND AFTER V-DAY

By E. DeGOLYER,
DeGolyer and McNaughton

SOME years back I went down to the University to teach. I don't know whether I was very successful as a teacher, but I certainly learned a lot while I was there. My various academic friends all rallied 'round and for about a year I received Phi Beta Kappa and Alpha Theta Phi keys and things like that, that they could not have conferred on me without learning the records of my own alma mater, and that is the University of Oklahoma. Some of them came back and said that there was just one thing left for me and that was to be the grand old man of the oil industry. Now I have been honored within the last few months by being invited to speak to your association and also invited to speak to the board of directors of the Standard Oil Company of New Jersey, and I figure that just about makes me the grand old man of the oil industry.

I am going to apologize to you for the remarks I am going to make this afternoon because not until about 10 o'clock this morning did I know that I was going to have to speak on "Drilling Requirements before and after V-Day." Possibly I can meet that requirement if we don't say how long before and how long after.

If I can make any remarks this afternoon that are of any advantage to you gentlemen in your business, I think that they are likely to be rather broad and general. When it comes to gearing drilling requirements down to a matter of months or years, I don't know how you can do a very good job. I am certain that I can't. What the immediate result of the close of the war may be on the requirements for drilling I don't know. As all of you know, there is a school of considered thought who feel that our oil requirements are likely to fall off about 15 per cent immediately following the war, and the basis upon which they reach these conclusions seem to be sound to me. I think the outlook is for decreased requirements as soon as the war is over, but there are a number of factors involved, and perhaps I should not try to be a prophet on such a narrow line as what the immediate prospects may be but had better confine myself to some tendencies that I can see and which certainly affect your business. We all know, though perhaps we seldom realize, how extensively our own nation is committed to an economy of oil consumption in tremendous quantities. For 1938, the last of the prewar years for which estimates are generally available, our consumption of petroleum products was in excess of one gallon per day per capita. The next highest rate was that of Germany, then vigorously stockpiling for war, with a corresponding consumption of approximately seven-tenths of a gallon. Canadian consumption was less than a half-gallon; that of the United Kingdom, less than two-tenths gallon; that of France thirteen-hundredth gallon; and that of Soviet Russia and of British India, to take two countries largely agricultural, was less than one-tenth gallon, and world consumption outside the United States was approximately 0.0043 gallon. Since the beginning of the oil industry and currently our country has produced approximately 60 per cent to two-thirds of the world's total production of oil. Our consumption has been in approximately the same proportion.

Discovery of important fields with stratigraphic type structures appears promising — wildcat drilling may increase; development decline.

The present war, during which some 65 per cent of all war supplies shipped overseas by this country consists of petroleum products, is proving clearly that oil is of even greater importance in time of war than it is in time of peace. It is not too brash a claim, perhaps, to say that this war will have been as truly won in the oil fields and refineries of our nation as was ever the Battle of Waterloo won upon the cricket fields of England.

It is obvious then that enormous supplies of petroleum and its products are essential to our national well-being in time of peace and a stark necessity for our national security in time of war. We cannot review too often the condition of our petroleum supply, the outlook for future supplies, and the steps that must be taken to keep our position sound.

What of our domestic supply? The nation has been warned periodically from the earliest days of the industry of the approaching exhaustion of its crude oil reserves. Since the event apprehended by these doleful prophecies has never transpired and since our current production is at an all-time high and our proved reserves are estimated to be as great or nearly as great as at any previous time, there would seem to be no apparent cause for immediate concern.

The situation, however, is not so simple as it appears to be. In order to maintain our production at current rates or even at what might be regarded as a normal peacetime rate, we must constantly discover new oil fields. Two-thirds of our current production comes from fields discovered since the beginning of 1928. Our ability to maintain our production and to maintain our reserves depends upon our ability to discover new reserves at a rate fast enough to offset depletion through normal current production. Whether or not we can do this and, if so, for how long we can do it, no one can say. The current results of exploration are not encouraging. Allowing for the fact that estimates of reserves for recent discoveries are notoriously inexact and subject to substantial revision, it appears that since 1938 we have not discovered in any year enough oil to replace that produced, and the outlook for a change in this adverse condition over any substantial period of time is not bright.

Now I could talk to you for a lot longer than you would be willing to listen on these statistics with regard to the discovery of new reserves. The only general figures which are available to us are those that the A.P.I. publishes each year, but they do not really attempt to make what I might call a free wheeling estimate of new discoveries. They simply try to make an estimate of oil that's proved up, and if a new field (assume an East Texas) came in at the end of a year they would simply give it a figure of say five million barrels, and then continue to add to it each year as the field was developed. Therefore the figure published is not a very fair index of discovery, and in discovery I think we have been falling behind beyond any question.

THIS brings us to the question of what undiscovered reserves of this nation may be. At the present, we have produced about 29,000,000,000 bbl. of a total world production of approximately 45,000,000,000 bbl. of oil. Our proved reserves are estimated to be approximately 20,000,000,000 bbl., making a total of some 49,000,000,000 bbl. thus far discovered in our country. What are the undiscovered reserves upon which our domestic position depends? No one knows. Several interesting speculations have been made, for no sound basis for estimates exists, and those speculations that have thus far received preferred attention are to the effect that the United States should ultimately produce approximately 100,000,000,000 bbl. of oil. On this basis there would remain a little more than 50,000,000,000 bbl. yet to be discovered. So you might say we are at the half-way point. Whatever the undiscovered reserves may be, however, there is no sound basis for estimate, and whether or not they are sufficient for our current and future requirements depends upon whether or not

*Presented at annual meeting of the American Association of Oilwell Drilling Contractors, Ft. Worth, Texas, August 3 and 4, 1944.

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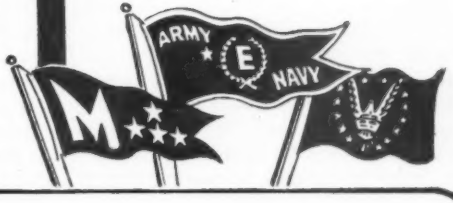

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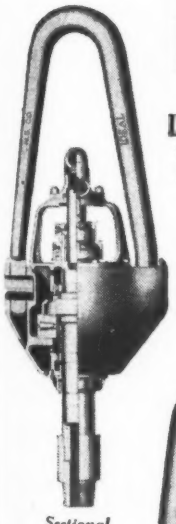

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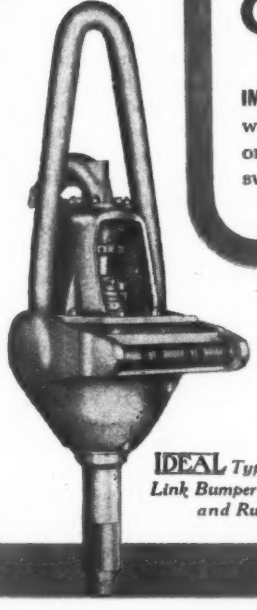

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they can be found and made available at the rate at which they are needed. Again, I say that the discovery rate of the past 6 years is unfavorable to a conclusion that they can be discovered.

It is interesting to attempt to analyze the figures of discovery. Presumably the reason we are short on discovery is because we are not finding very many but very small oil fields, and compared with the 6 or 8 years preceding 1938, we are finding very few large fields.

The average person who gives the matter of oil production any serious general consideration is likely to be lulled into a false sense of security by finding that our total oil production comes currently from more than 400,000 oil wells and to regard so great a number of sources as indicating a great degree of stability. This line of reasoning has some merit but, if I may revise an old saying of the oil industry, the backbone of our oil production is flush production rather than the old and settled production. Half of our production comes currently from 8 per cent of our wells; an additional 35 per cent of our production comes from 10 per cent of our wells. This leaves approximately 15 per cent of our production to come from the remaining 72 per cent of the wells—the stripper wells.

These statistics are not alarming. A similar well-distribution has probably been true for many years. It only serves to emphasize the degree to which we are always dependent upon flush production, upon production from large wells that are normally drilled in newly discovered fields within a few years of their discovery. If we assume for a moment that all known fields were fully drilled and that no new ones were to be discovered—in other words, if drilling stopped—our production would be down as much as 40 to 50 per cent below its current rate within 4 years. Aside from the admitted desirability of maintaining reserves, this condition emphasizes the necessity of continued finding of new fields as a source of flush production if anything like the current daily rate of output is to be sustained.

Now I would be inclined to think that within the next 2 or 3 years the shortage of discovery that has been true since 1938 is likely to show itself in the drilling programs. The bulk of the drilling in any year is development wells, to develop fields that have been discovered within, for the most part, 3 years previously, and the shortage in discovery that we have faced must reflect itself sooner or later in the shortage in the amount of drilling to be done. On the other hand, when we consider the wildcat situation, I should think that the prospectors (and I mean by the prospector the technical prospector, the geologist, and the geophysicist) are about to run out of hole. There are less prospects, there are fewer prospects being found currently for the amount of work being done, and the prospects do not average as high as those from, say, the period of 1930 to about 1938. From the standpoint of the man who is interested in drilling wells that means essentially that we are more or less exhausting our current technique of discovery, and that we must depend, as we did in the beginning, again more than ever before upon the drilling of wells. Much of the oil that has been found in this period, from about 1913 on, has resulted from drilling structures in order to try to find new oil fields. That was a successful period, but we have about run out of structures.

None of these generalizations is absolutely true, but I think the bulk of the oil in the future will have to come from the stratigraphic trap types, and up to now we don't know of any way to find those stratigraphic traps except by drilling wells. The question of proving up a stratigraphic prospect is a good deal more difficult than proving that structures exist. If you have a structure you drill the well on top of it, and you have either oil or gas, or a dry hole. If you got a dry hole you generally regarded your prospect as a failure and abandoned it. In drilling for a stratigraphic trap type of prospect (and I am talking about fields like East Texas or West Edmond and many of the California fields, the great fields of the Maracaibo Lake region, Burbank, and any number of great fields), it is easily conceivable to me as a geologist that a man could drill 8 or 10 dry holes before he knew where to put the ninth or the eleventh well, which he would regard as being more or less definitive; so that in order to find 100,000,000,000 bbl. in the future it is my belief that we are likely to have to drill as many as 4 or 5 times as many dry holes as was required in the time of prospecting the structural traps.

Something more than a year ago when I was in PAW we made some very interesting studies from the standpoint of national production to see what the effect of drilling might be. I am sorry that I don't have those graphs because they are very impressive. They look like they were drafted by some very skilled mathematician, but as a matter of fact they were made up with methods that didn't go far beyond the third grade. By analyzing the fields of the United States, we found that the average expectancy for every oil well in the United States was something in the order of sixty to seventy thousand barrels. That was arrived at by dividing the total past production in the United States plus the estimated proved reserve by the number of oil wells. We found one company that kept statistics on their wells by groups according to the year in which they were drilled, and from their records we took a curve for a group of about 300 wells drilled in the same year, which worked out at about this national average I have just mentioned. Then upon the assumption that one had an indefinite amount of territory to drill and that he could always have about the same results as that one company, we simply shingled on a set of curves for each year. We had to assume further that the average life of a well would be about 20 years. On those bases we got on to a maximum production at the end of the twentieth year, but we found after that shingling on these additional years only kept your production level where it ran on to an indefinite time. Upon investigation of those curves we found the very interesting fact that at any time at the end of about 4 years on that assumption, or that set of assumptions, if you did not drill any more, your production would be down to about 50 per cent of what it was in the year in which you started. Well, we got pretty far along with assumptions. The whole thing seemed to be a little theoretical, and I became very much interested to find out whether there was any correlation we could make with existing conditions that would give us more faith in these conclusions or that might tend to disprove them. Of course we were restricted as to what additional information we could get and finally the only comparison we could make was between the percentage of the wells according to size. So we made a distribution curve for our theoretical curve on the wells according to size. We went back and made a similar distribution curve for all the wells in the United States. These two curves did not fit very well, but upon inspection we decided that the Appalachian field did not fit in very well and we took only the wells west of the Mississippi River, and these two curves of distribution fit almost exactly; and I for one believe that if 85 per cent of the production comes from 18 per cent of our wells, and we stopped drilling tomorrow, within 4 years we would be down to 50 per cent of our production. It is the new wells, the flush wells that keep the production up.

Exploration in the Unted States, as measured by the number of wildcat wells drilled or by the number of geophysical crews and core drill crews in operation, and these are excellent indices, is and has been for some time at or near an all-time peak. Intelligently directed exploration is certainly at as high a rate as it has been at any time in the past. The results of such effort, however, have been for some time now below our hope and normal expectation. What is the cause for this unsatisfactory condition? In my opinion, it lies in our failure to discover large fields at a rate as great as we have discovered them in the past.

Now you gentlemen are undoubtedly interested in what effect this has on your business. Personally, I think if you try to look forward into the question of oil wells that are likely to be drilled for primary production within the next 4 or 5 years, you are likely to be facing a decline in the number of wells year by year. I think if you look at the wildcat wells that you are likely to see a substantial increase in the number of wells year by year because, except for geological theorizing, I believe it is going to be continuingly more difficult to find oil, and I believe it will take many more wells to do it. As I guess the sense of the feeling of the big companies about their exploration programs, from California back to the Mississippi River, they are discouraged on account of the small number of prospects and the result is that many of them are moving in the direction of foreign fields. Oddly enough this al-

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most parallels the happenings at the end of the last war. The United States was not notably important as a producer of oil in foreign fields until about the end of the last war, when the companies became concerned as they are now with regard to the paucity of prospects in the United States and decided to go abroad.

We are not exactly happy with the number of pools that have been found in the United States. As near as we can guess it is between 4000 and 5000, depending upon how you describe pools. Say that there are 4000 to 5000 pools, almost two-thirds of the oil has been discovered in the hundred largest pools, the bonanza pools. The greatest of these bonanza pools, the East Texas, represents approximately 10 per cent of all the oil ever discovered in the United States. The smallest of such pools, with reserves of approximately 100,000,000 bbl., represents about one-fifth of one per cent of all discovered. During the 6-year period, 1933 to 1938, inclusive, approximately 22 bonanza pools were discovered; during the almost equal period that has elapsed since the end of 1938, only 6 or 7 such pools appear to have been discovered. We are finding more fields but their average size is increasingly and distressingly smaller.

I think if we could study exploration technically and more or less dispassionately that we could do it better than we do it today. One year one man seizes upon the loss of discovery to prove that we ought to have a price increase. Within the past year the Standard of New Jersey has put on a campaign that there is undoubtedly plenty of oil and we don't need to bother about it. I think it would be well for your association to put on a program to study this thing. They could estimate to within a very few per cent of the actual material requirements for the incoming year. I think this association could work by states and could work the problem out and come to within a very small per cent of the exact amount of drilling that is to be done. The Standard—I suppose I might as well call it—propaganda is more or less to the effect that there are 50,000,000,000 bbl. of oil still to be discovered in the United States in addition to that which has already been discovered. Both are good, round, mouth-filling figures. Probably the first engineer or geologist who ever tried to estimate what was to be discovered in the United States shook his head and said, "Well, there ought to be as much to be discovered in the future as in the past." I have no idea whether 50,000,000,000 bbl. for the United States is right or not. I think it is too high. But I must admit that when Dad Joiner can go out and find 10 per cent of all the oil we have already found in the United States, that anybody is making a hazardous guess when he tries to estimate what it may be. I would say that it is going to be a great deal more difficult to find in the future than it has been in the past, and I think it can be found only by the drilling of wells. I mean that you will not only have to dig the oil out of the ground to find your pools, as I have suggested, but you will have to dig the prospect out of the ground with the drill.

During the past year or so I have had some little experience in foreign work, and as a matter of fact my earliest experience in the oil business was in foreign work, and I think that there is a great opportunity for the drilling contractor if he can bring himself to it. I know we would get along a lot faster in the foreign work if we had American contractors drilling the wells; and it seems to me that there are opportunities in those fields for the men in your business.

I have little or no patience with the viewpoint of some independent producers who feel that the nation should give no concern, no protection, or give nothing else to the American who is in foreign fields. He is doing just as great a thing for his country as any man who finds oil in the United States. Possibly he is doing a greater thing, for he is working under greater difficulties and possibly in greater units, and I think it is highly important that we keep the dominant position that we have at present; and if the so-called technical know-how and the venture-minded capital that is available to Americans is as good in the future as it has been in the past it will assure that position.

The position of our nationals in foreign fields is reasonably satisfactory.

In the Middle East, the area of apparent greatest potential importance in the oil world, our nationals have a minor position as to current production and refining and a satisfactory position as to reserves and prospects. The oil fields of Iran, from which the bulk of current production comes and which represent the greatest developed reserve, are controlled entirely by the Anglo-Iranian Oil Company, Ltd., in which the British government has a majority share interest. Iraq Petroleum Company, Ltd., controls the oil fields of Iraq, from which substantial production goes by pipe line to the Eastern Mediterranean, and owns as well, important concessions in Syria, Palestine, and in various shiekdoms along the shores of the Persian Gulf. It is owned in slightly less than a quarter interest each by Anglo Iranian, the Royal Dutch Shell group, a French group, and an American group. The great oil field of Kuwait is owned one-half each by Anglo Iranian and an American company. I visited this Kuwait field and I thought in East Texas I had seen the last word in oil fields, but this particular field had been half proved and it was estimated that the half that was proved would be good for 4,500,000,000 bbl. If we assume it was as good on the other half, that would be good for another 4,500,000,000 bbl.

In South America, our nationals have a majority position in Venezuela, in Peru, and, unless recent developments have reversed it, a majority position in Colombia.

The American position in Mexico was lost through expropriation. The relatively unimportant position in Bolivia was likewise lost through nationalization. The oil fields of the Argentine are chiefly operated by the Argentine government and the American position is of minor importance. Likewise, the American position in Trinidad, a British colony, is of little if any consequence.

It seems to be probable, again sort of following the history of the last war, that the rivalries for oil rights and concessions similar to those that marked the close of the First World War are likely to repeat themselves with the close of the present conflict.

Now in these rather general remarks in regard to what the future looks like to me, there is one point that has not been considered, and that is the question of secondary recovery; and I don't feel that I could contribute anything to that. I presume that we will make every possible effort in the United States to keep our production to the highest possible point as long as we can. It may be that some day we will go on to alcohol from agricultural products, oil from shale, etc. It seems to me that the whole thing is a matter of costs, and I can't conceive that our nation is likely to go on a potato-sugarcane-alcohol motor fuel basis as long as oil can be produced and laid down here on a cheap basis. ★★★

Shell postwar plan

Shell Oil Company, Inc., has announced a postwar employment plan under which it will give jobs to all personnel currently in military service, will retain all regular employees who have stayed on during the war, and will continue to the fullest possible extent the employment of new people who temporarily replaced those in service. This will be made possible, Shell officials said, because of the development of many new uses for petroleum.

"Petroleum molecules," said the company announcement, "instead of serving only as fuels and lubricants, are now being reformed by scientists to serve as the starting point for new industries that create new jobs." One example cited was a process by which allyl chloride can be made from petroleum material. This process, discovered and developed by Shell research, will provide allyl chloride commercially for postwar use in construction materials, plastics, pharmaceuticals, insecticides, finishes, and soil fumigants.

Company officials said that previous to the war Shell's employment was about 28,000.

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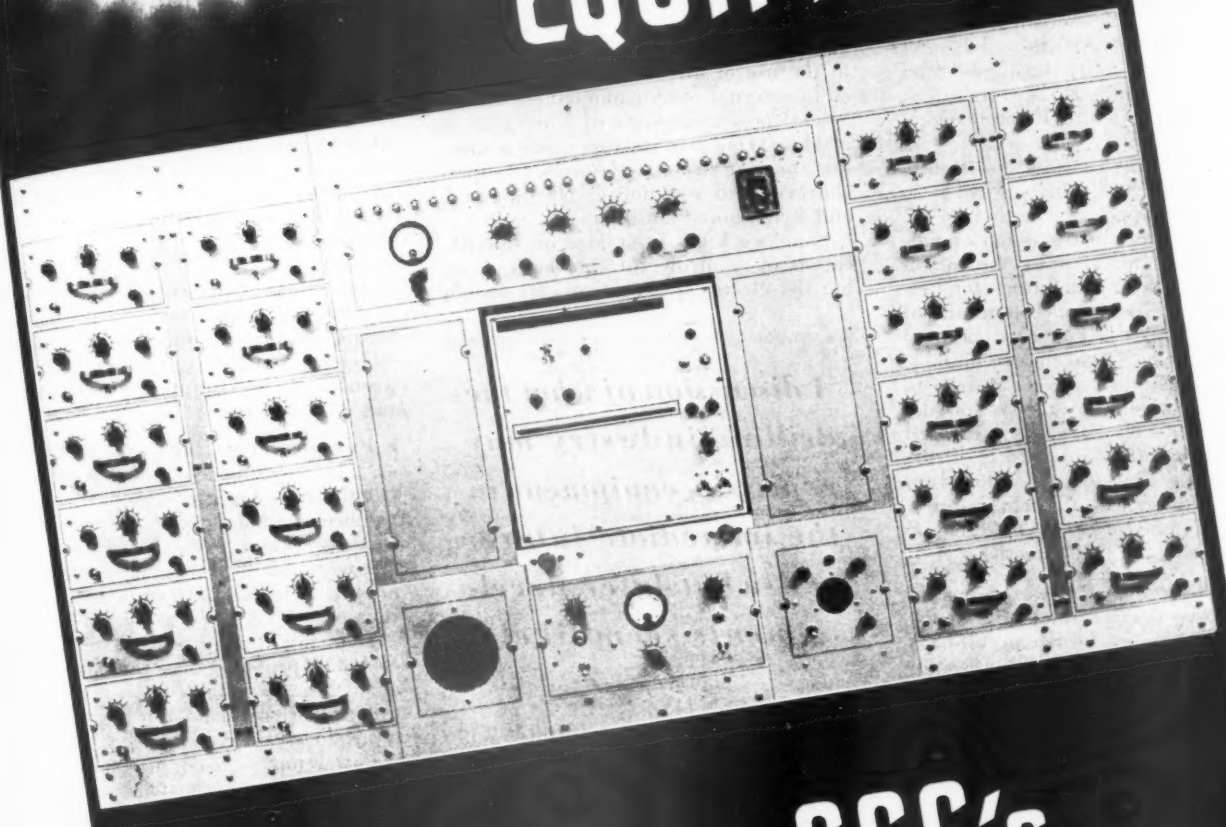

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ROTARY DRILLING EQUIPMENT

By **JOHN A. CHAPMAN,** *Vice President*
Grey Wolf Drilling Company

I WOULD like to say first that these ideas that I have put out are primarily my own and those assembled from some of my friends in the drilling business, and if there is any criticism please offer it when I get through. Don't start throwing rocks at me before I get through, please.

I have been asked to talk on "Rotary Drilling Equipment." This subject is so large that I have chosen rather to restrict this paper to a discussion of new equipment contemplated by the manufacturers and recommendations for new equipment received from operators of rotary drilling rigs. For ease in handling, this report is broken into units.

The one thought of all operators is to maintain or increase capacity and decrease weight. The greatly increased production for the war effort of the lighter metals that can be alloyed to strength suitable for oil field requirements, will undoubtedly be of some assistance in reaching this objective.

▸ **Drawworks or hoists.** Power rig manufacturers have demonstrated that speed changes can be made in an oil-bath housing on short centers. This has eliminated the need for the jackshaft and lineshaft. It is necessary to have a catheadshaft, but this need not be any larger than required for actual power utilized for catheading. Why should steam and electric rigs not utilize this development and greatly reduce the weight and consequent cost?

The prime cause of mechanical power rig failures has been the high starting torque requirements for hoisting. This applies equally to the hoist and the internal-combustion engines. Many of the manufacturers have used or contemplate using torque converters or hydraulic drives that will give the necessary torque characteristics at constant engine speeds.

To date the principal problems in hydraulic drives have arisen due to inadequate capacity of drives now on the market and overheating. These two objections will, we believe, be overcome as soon as the manufacturers get back on a peace time basis. Incidentally, the manufacturers have developed and are using on war projects hydraulic drives of bigger capacity than those that have been placed on the market. The use of hydraulic drive will require the transmissions designed to handle the greatly increased torque. It is not practical to place a torque converter between the engines and transmission on rigs now built that have not been designed to handle the additional torque.

It is our belief that for the deep drilling at depths from 10,000 to 15,000 ft. where cheap fuel and abundant water are not available, we will see an increase in the use of direct-current rigs powered by internal-combustion motors having a total power capacity of from 1000 to 2000 hp. One manufacturer now is making for war use diesel engines, supercharged, that will deliver 600 hp. each and weigh about 25 lb. per hp.

Some work has been done on simplification of controls for d-c. equipment, but the electrical manufacturers should strive for even simpler controls. With the return of the boys that the navy has trained in handling diesel equipment we should have, for the first time, an adequate supply of men who are properly trained for diesel and electrical maintenance.

A discussion of what the drilling industry may expect in equipment in the immediate future, and what later developments seem likely.

Magnetic or electrical braking should and will be developed, thereby reducing the weight required for auxiliary brakes now being used.

Increased diameter of drum centers for hoists of all sizes will greatly improve wire rope performance and should shorten the distance between bearing centers due to greater capacity of the larger drums.

▸ **Blocks.** The present tendency toward increased sheave diameters will continue. One manufacturer has greatly increased bearing capacities by mounting the sheaves on a drum rather than a shaft.

The need for weight in the traveling block has decreased directly in proportion to the improved efficiency of roller bearing drums. This probably could be carried to a point where all beams, side plates, and bars both for the traveling and the crown blocks could be made from the lighter metals, such as magnesium, properly alloyed. I will admit that there is some question on the weight of the traveling block, but it is not necessary to load the blocks as we have.

▸ **Swivels.** The past few years have seen the passing of the idea that it is necessary to build swivels of great size and weight to carry the heavier loads. Manufacturers are now utilizing finer bearings and are reducing weights by better load distribution and use of better steel in swivel bodies. This is illustrated by two swivels now on the market, both of which are capable of drilling to approximately 15,000 ft. with 4½ in. pipe, one weighing 6000 lb. and the other 3500 lb. Improvements in metallurgy should permit even further weight reductions in the near future.

▸ **Rotaries.** Practically all manufacturers now build rotaries capable of handling all requirements up to top speeds of 500 r.p.m. However, they have not reduced the weight of the unit. The use of lighter metals for the base and possibly even the table top, should reduce the weight by half without sacrifice of capacity.

Direct table drives with both steam and internal-combustion motors, through torque converters, have been found satisfactory, and the rig of the future will probably be so equipped. Direct-current rigs will have motor direct driven tables.

▸ **Pumps.** Pumps, both steam and power, have continued to get heavier as capacities have been increased. This trend has been halted somewhat by the use of cast-steel water ends. These steel ends are more inclined to cut out than the alloyed iron end, but can be more easily repaired.

The straight reciprocating steam pump of today probably has the most desirable characteristics for rotary drilling when plenty of steam, not too expensively produced, is available.

Power pumps used in rotary drilling have not been so constructed that they maintain the even flow of mud and constant pressures of the steam pump. It is true that when driven by a d-c. motor or steam engine, constant pressures can be maintained, but the four high peaks per revolution are still there. In addition to this objection, power pumps as now constructed can stand only a limited amount of increased torque as speeds decrease.

There is at least one pipe-line power pump that maintains constant pressure at constant speed yet gives variable capacity. This is in effect, insofar as drilling is concerned, the performance of the steam pump that is so much desired. The steam pump gets its constant pressure through speed variation. The attribute of the pipe-line pump referred to, of constant speed, would make it suitable for mechanical rig operation or, for that matter, for any power rig application.

Power pumps for deep drilling have in the past had inadequate power ends, the largest, to my knowledge, having but 425-hp. rating. A 20-in. pump with 7½-in. liners operating at 40 r.p.m. at 1200-lb. pressure has a hydraulic output of more than 400 hp. To this must be added about 50 hp. to compensate for friction and loss of efficiency in the pump itself. This output is in the normal range of large steam pumps yet the largest power

*Presented at annual meeting of the American Association of Oilwell Drilling Contractors, Fort Worth, Texas, August 3 and 4, 1944.

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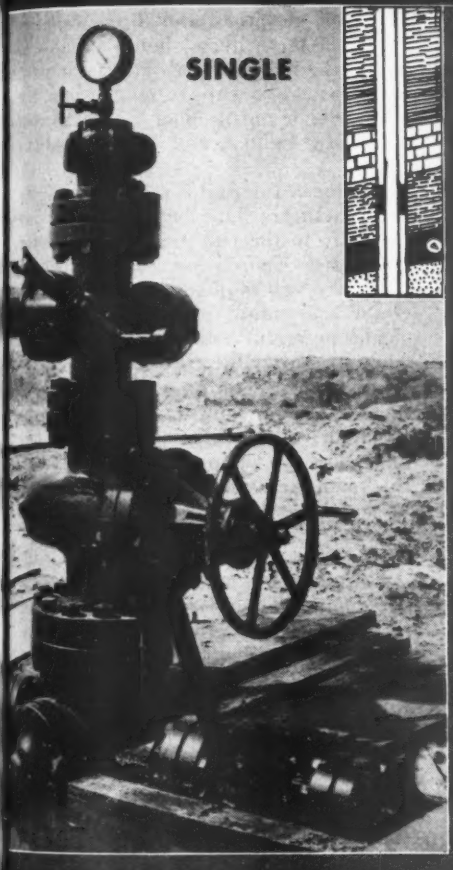

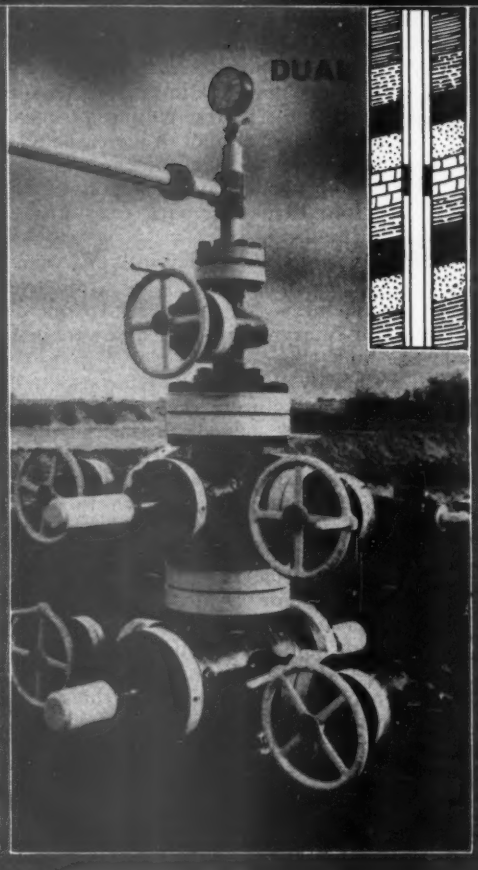

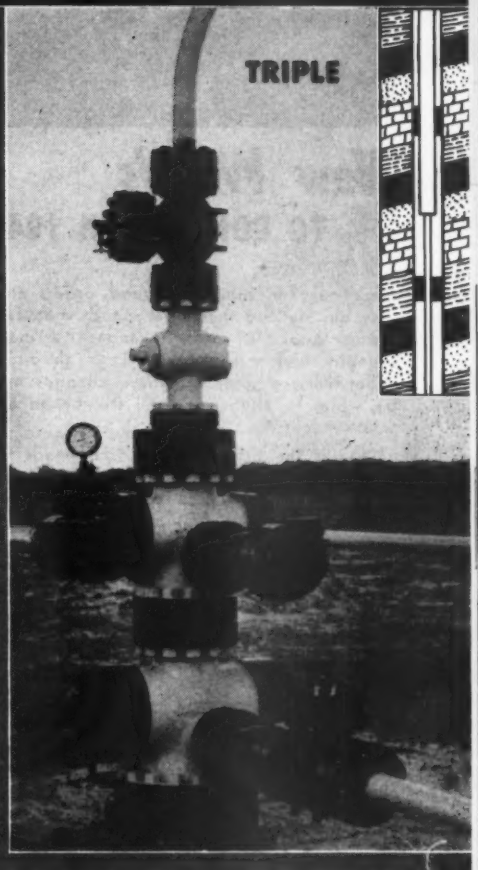

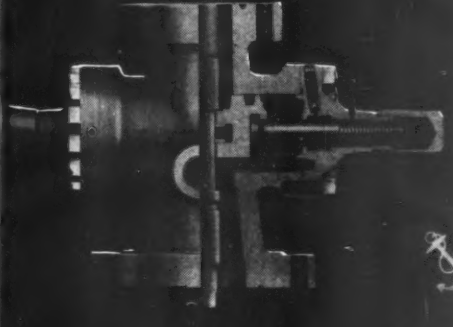

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One pump manufacturer has on his drawing boards a design for a 700-hp. power end for a triplex pump. The triplex feature will greatly reduce the peak loads, and the capacity of the power end is adequate for deep drilling, but the Lord only knows what it will weigh. Incidentally, there is one pump now being used in the field that has this triplex feature, but the power end is rated at approximately 400 hp.

What we would all like to have is a pump with the characteristics of the pipeline pump described with adequate power end, however it may be accomplished.

▸ **Boilers.** Boiler manufacturers are now giving us greatly improved performance in the newer boilers, due to increased furnace volume and decreased length of tubes. Some manufacturers have built 150 hp. by 350 lb. working pressure boilers that weigh no more than the old 125-hp. boilers due to increased tensile strength of the plates. We do not know what the practical limit of increased tensile and reduced plate thickness is, but every step up to that point is a step in the right direction with consequent weight reduction.

▸ **Drill pipe and tool joints.** We treat this as one item although, as a rule, two manufacturers are involved. To operators of rotary equipment, however, it is one tool.

Primarily through the efforts of tool joint manufacturers the most common type of failure, namely the last engaged thread, has been eliminated. One manufacturer of drill pipe has eliminated this by upsetting the tool joint from the body of the pipe. In doing this he had to make the pipe of alloy steel with tensile strength considerably in excess of conventional grade D steel. In so doing, he practically doubled the torsional strength and thus eliminated twist-offs, in the body of the pipe.

There is some point of wall thickness, less than that now used, in steel of a better grade than D, where the pipe would be as strong or stronger than 16.60-lb. grade D pipe and yet be considerably lighter than the pipe most of us now use. Steel company metallurgists and engineers can take over from here as to the necessary weights and thickness. This would be true whether the joint were upset, flash welded, or shrunk on. A reduction of weight, whether 10, 15 or 20 per cent, would save many ton miles of hauling and hoisting.

▸ **Kellies and drill collars.** Most of us would welcome the return of prewar steel such as 3140 or 4140 for these two items, but we have reason to believe that even better alloys will be available after the war.

The release of gun barrel machines for peace time operations should assure us of receiving collars bored true enough to satisfy even the advocates of 500 r.p.m. rotation.

▸ **Tongs, elevators, and slips.** Manufacturers of these items should be able to utilize the lighter metals at least in part. With tongs and slips of magnesium, the actual labor on the floor would be considerably lighter and the operations faster.

▸ **Engines.** Internal-combustion engine manufacturers have been working successfully to the end that we desire for rotary rigs. There is no reason to believe that they will stop now, but rather we could reasonably expect even greater strides in weight reduction and increased capacities after the war.

▸ **Well control equipment.** We now have in use a new blowout preventer that eliminates practically all the time formerly lost in changing rams. In addition this manufacturer has reduced the overall height and reduced the weight materially.

No forecast of things to come in drilling equipment would be complete without mentioning collapsible bits that can be retrieved and replaced with a coring line, and the independently operated bit driven by fluid power. These two items will come in time, but I have endeavored to present some of the improvements that we should have in the immediate future.

★★★

Predicts myriad new oil compounds

Dr. Gustav Egloff, director of research, Universal Oil Products Company, Chicago, has estimated that more than a million new oil compounds may be produced from petroleum and natural gas. This assertion was made in view of the great number of hydrocarbons available as starting materials. Dr. Egloff said that natural gas and petroleum are veritable treasure troves of paraffin, olefin, acetylene, cycloparaffin, cyclo-olefin, and aromatic hydrocarbons all of which will offer endless opportunity in chemical research.

Speaking, on the other hand, of increased production of aviation fuel and synthetic rubbers as examples of quick development of chemical processes, he pointed out that production on July 1 was 500,000 bbl. daily of 100-octane plus gasoline, or more than 11 per cent of the crude production, and that it was predicted by the end of the year 15 per cent of the crude production will be converted to aviation fuel. Products of the chemical industry founded on petroleum and natural gas, Dr. Egloff said, represent less than 1 per cent by weight. There should be no basis for concern about raw materials as we have ample oil supplies for our needs for many years to come, he predicted.

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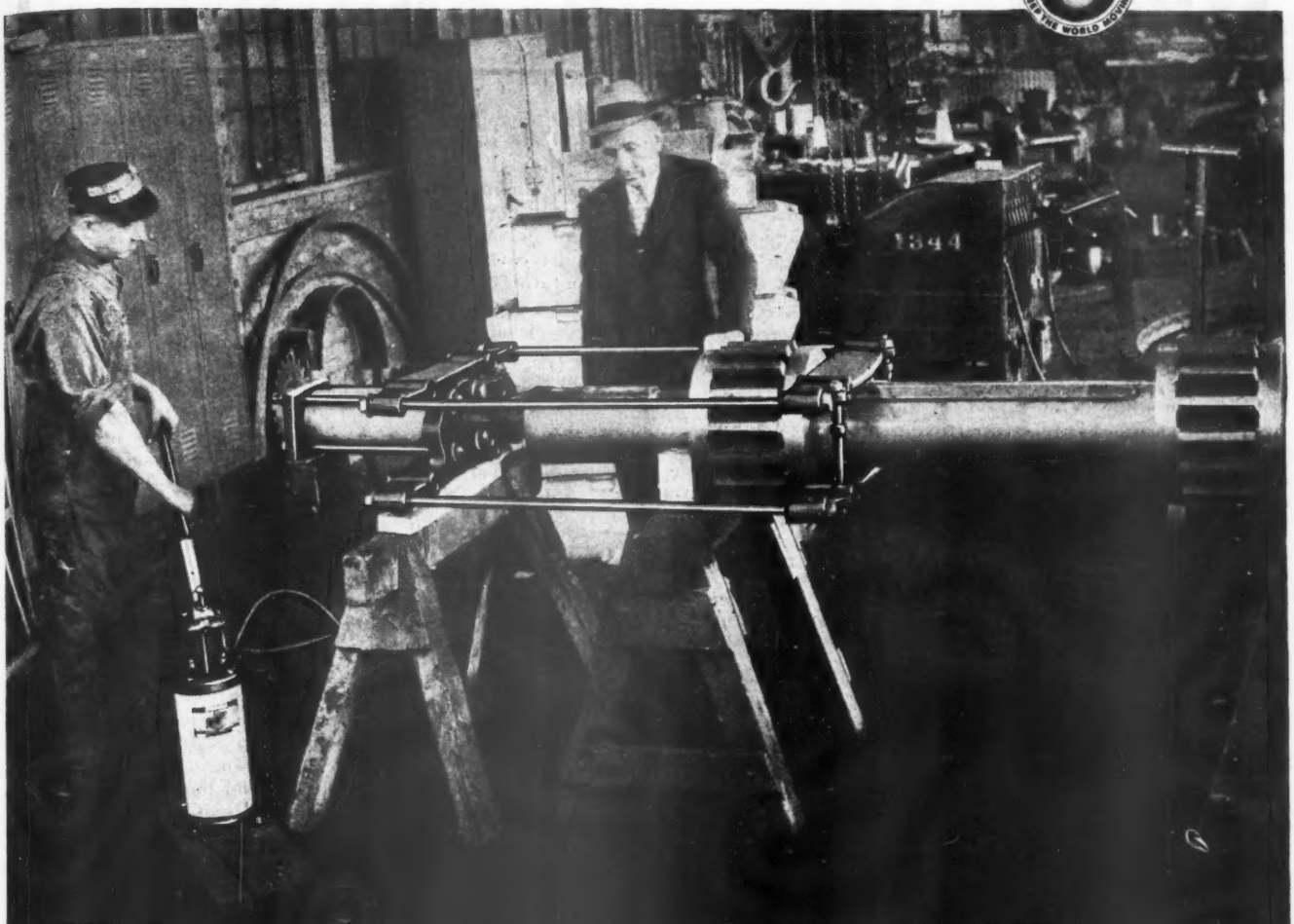

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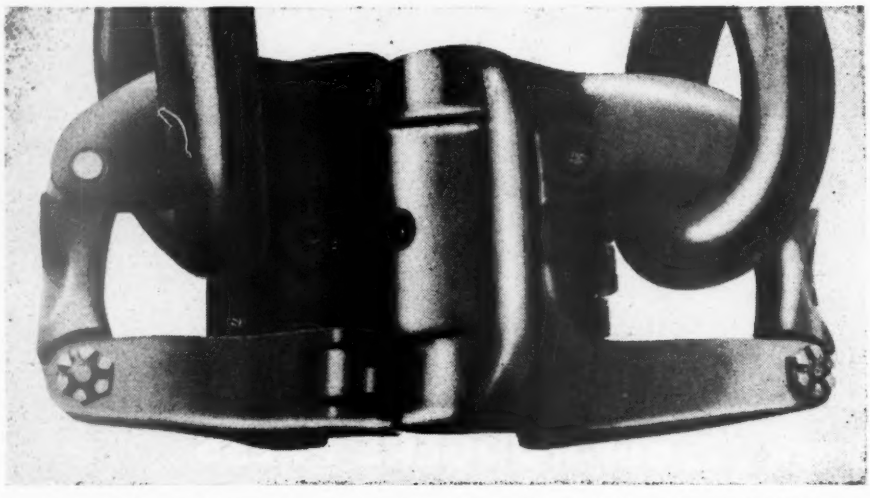
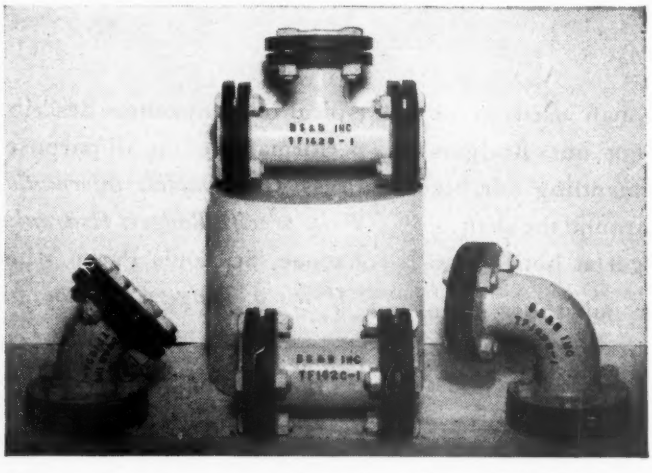
Material of the new "AA" elevator is heat-treated, high alloy steel. The top bore is flame hardened to guard against upsetting. The safety factor is rated four to one, 300 tons.

For further information write to Byron Jackson Company, P. O. Box 2017, Terminal Annex, Los Angeles 54, California.



Slip-union

New equipment now in production at Black, Sivalls and Bryson, Oklahoma City, Oklahoma, includes slip-union fittings of an unusual design that will eliminate many pipe-fitting problems. Slip-union fittings make threads or grooves unnecessary, and eliminate the use of expensive pipe dies and trouble with cross threads, it is stated.



Other advantages asserted for BS&B slip-union fittings are that each fitting is a union; connections need not be accurately lined because the new slip-unions permit up to an 8 degree deviation from a straight line, and highly skilled labor is not needed as inexperienced men find they are easy and quick to line up, requiring only a crescent wrench to make up.

The drilling on all these fittings is Standard ASA 125 lb. Conversion from threaded to slip-union connections is easy as either the fitting itself or the loose flanges can be bolted directly to any flanged standard ASA 125-lb. fitting.

In addition to a saving in time and labor, the fittings, made of heavy cast-iron, also save money as they can be used over and over merely by replacing the inexpensive, molded gasket, it is pointed out.

Industrial thermometer

A new industrial thermometer with a plastic case front, yellow back, easy reading thermometer tubing, and malleable iron back has been announced by the C. J. TAGliabue Manufacturing Company, of Brooklyn, New York.

By using a plastic case front, weight is reduced and an adequate substitute for metal is provided. The plastic case front is not affected by the temperatures to which the case is subjected under actual service conditions. Either the glass or the entire front can be replaced at nominal cost.

Yellow back lens front thermometer tubing is a great improvement over the white back type, according to the manufacturer, because the yellow background offers the best color contrast with the mercury. The tubing also is comparatively easy to produce and it involves no complicated construction of bore or lens.

Malleable iron has been found to be an entirely satisfactory substitute metal for the brass formerly used, and is fully protected against corrosion by a durable black finish.

Cochrane C-B system

The Cochrane C-B unit completely solves the return of condensate from process equipment operating at pressures up to 200 lb. directly back to the boiler without flash loss and with all sensible heat contained in the original steam. Fuel savings of from 10 to 15 per cent are obtained, boiler pressure more easily maintained, and boiler capacity increased, the manufacturer states.

More important than these benefits are the higher production rates made possible by the patented jet pumping principle involved. All condensate, noncondensible gases, and entrained air are easily handled by the jet at high temperature with a constant differential maintained across the equipment creating positive drainage, with entrained air automatically discharged from the closed circuit before return to the boiler.

Because of the high back pressure maintained against the equipment, with constant flow of gases and liquids, there is no appreciable pressure drop in the steam chambers, as is the case when discharging to atmosphere or a low pressure. Hence, heat transfer rates are higher and more uniform, resulting in hotter heating surfaces, greater production at the same steam pressures, with less fuel costs.

Write to Cochrane Corporation, 17th and Allegheny Avenue, Philadelphia 32, Pennsylvania, for Publication No. 3250.

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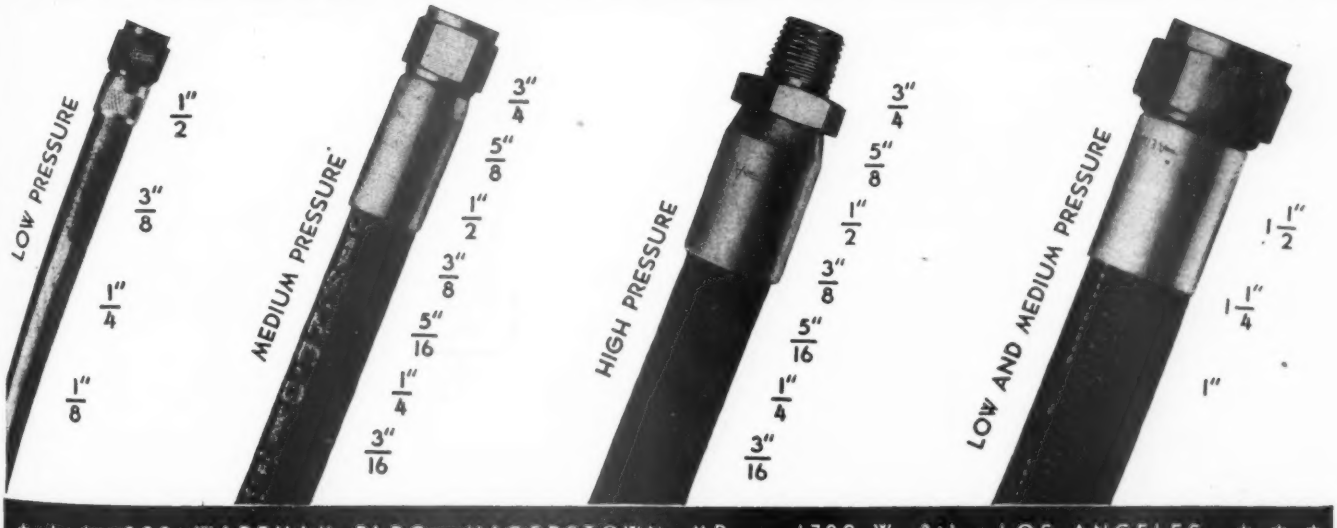


★ ★ ★ 303 WAREHAM BLDG., HAGERSTOWN, MD. - 1709 W. 8th., LOS ANGELES ★ ★ ★

Emsco triplex slush pump; portable mast

The Emsco Derrick and Equipment Company announces the addition of two new items to its line of oil-field drilling equipment. Designed after long and careful study by the Emsco research and engineering departments, the Emsco A-10 triplex slush pump and Emsco 12-P portable mast now offered to the trade have many features of interest.

Emsco A-10 triplex slush pump. The A-10 triplex is an all-steel power pump having three double-acting cylinders. The fluid end and the power end are made of cast-steel and structural shapes, which makes the entire unit extremely light and very rugged in construction.

The advantages of a 3-cylinder or triplex pump, according to the manufacturer, are its uniform power requirement during operation and the elimination of high and low surges. For example, a 12-in. stroke double acting duplex power pump equipped with 7¼-in. liners producing a mean effective pressure of 445 lb. has a high surge pressure of 620 lb. and a low pressure of 340 lb., a difference of 280 lb. between high and low, it is pointed out. The horsepower consumption at peak surge pressure will be 228 hp., whereas at low pressure it is 126 hp. This produces an unbalanced condition and forces the prime mover to adjust itself to the horsepower requirements of the pump. The duplex pump as described above will have four unequal surges of 540 lb., 620 lb., 475 lb., and 410 lb. during one revolution of the crank.

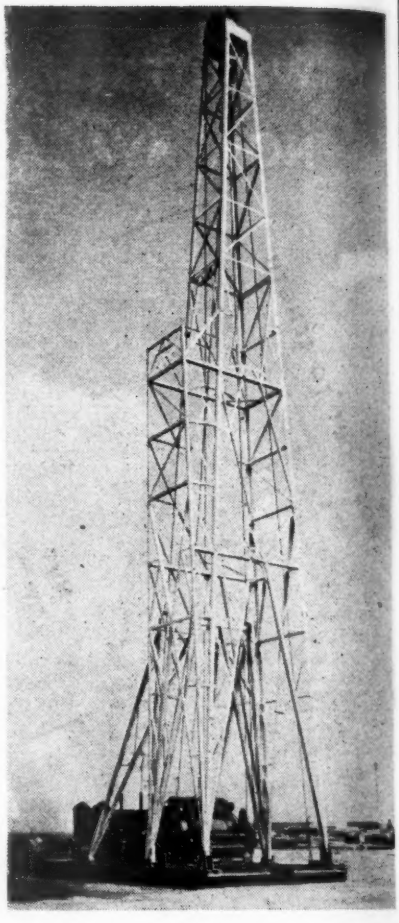
A triplex pump having 6¼-in. liners and a 10-in. stroke, producing a mean effective pressure of 440 lb., will have six uniform surges of almost equal pressure and at even intervals, the makers assert. The high pressure in this case will be 465 lb. and the low will be 375 lb., or a difference of 90 lb. The horsepower requirement of the triplex pump at peak pressures will be 230 hp., six times per revolution of the crank, and 187 hp. at low pressure during the same cycle. These even and uniform surges of low intensity will allow the prime mover to operate at a more constant power output, it is stated.

The Emsco A-10 triplex slush pump incorporates all features that have made Emsco slush pumps popular in the field. These include all-steel construction, light weight, exposed type fluid liners, a fluid end easily repaired in the field by welding, renewable crosshead guides in frame, and compact, rigidly welded power end frame. It also utilizes the Emsco design of suction and discharge valves of the same size, in the same pot, and under one valve cover. This provides ease of access, permits a substantial reduction in weight, and allows an extremely narrow construction.

Emsco 12-P portable mast. The Emsco 12-P portable mast is fabricated in 7 welded sections for convenient transportation. These sections are quickly and easily assembled on the ground or on cribbing. The crown and traveling blocks are strung for drilling and, with the aid of an auxiliary line, the mast is raised by the drawworks. The skid base breaks down to road widths for hauling and is supplied in lengths to suit the rig. Any standard unitized drawworks and any rotary table may be used.

Perfect visibility, resulting in safety, is permitted because: Patented bulge construction for inside racking makes it possible to eliminate an open face and thus avoid interior bracing; the line arrangement used in raising and lowering the mast avoids the use of interior trusses; the legs are spaced symmetrically with respect to the center of the well, resulting in exceptionally favorable working conditions on the floor; a high V window affords the advantages of an open face without the disadvantages. These features give perfect visibility between the driller and the working platform and clear unobstructed working space inside the mast.

The method by which the 12-P mast is raised and lowered overcomes any possible safety hazard, the manufacturer states. A positive strain is kept on the line at all times during the raising or lowering operation by means of a pivot point change. The center of rotation is shifted by an arrangement of the base connections, making it unnecessary to pull the mast off center when lowering it or to use a snub line when raising it. In other words, the center of gravity of the mast never passes over the pivot point and thus a slack line cannot develop. A dropped mast is not possible and safety is assured.



Emsco 12-P portable mast.

Other features of the 12-P mast as pointed out by the makers are:

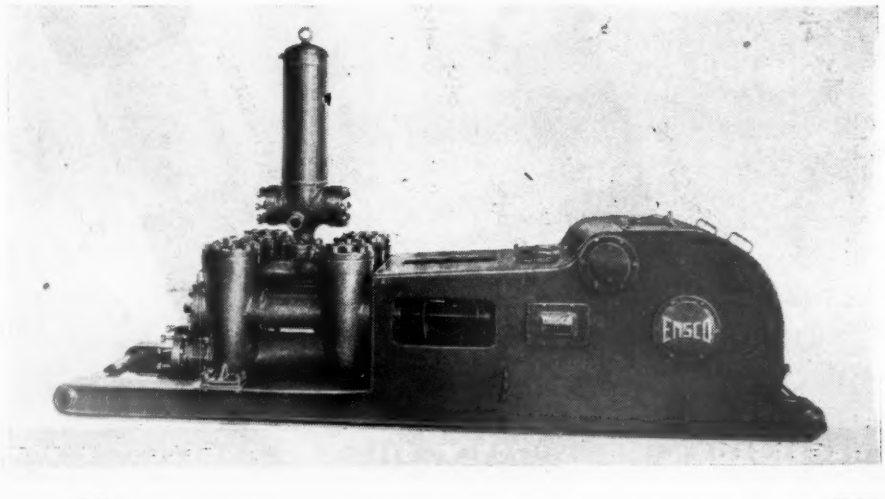
Lacing of all four faces results in a stiffer mast than can be secured by internal bracing. No guying is necessary.

The crown block is concentrically mounted, resulting in an equal loading of the legs. This means better distribution of the load on the foundation.

Working platforms are floored with heavy expanded metals, providing a non-slip surface without interfering with visibility. The platforms are hinged and can be folded up against the face of the mast, if desired.

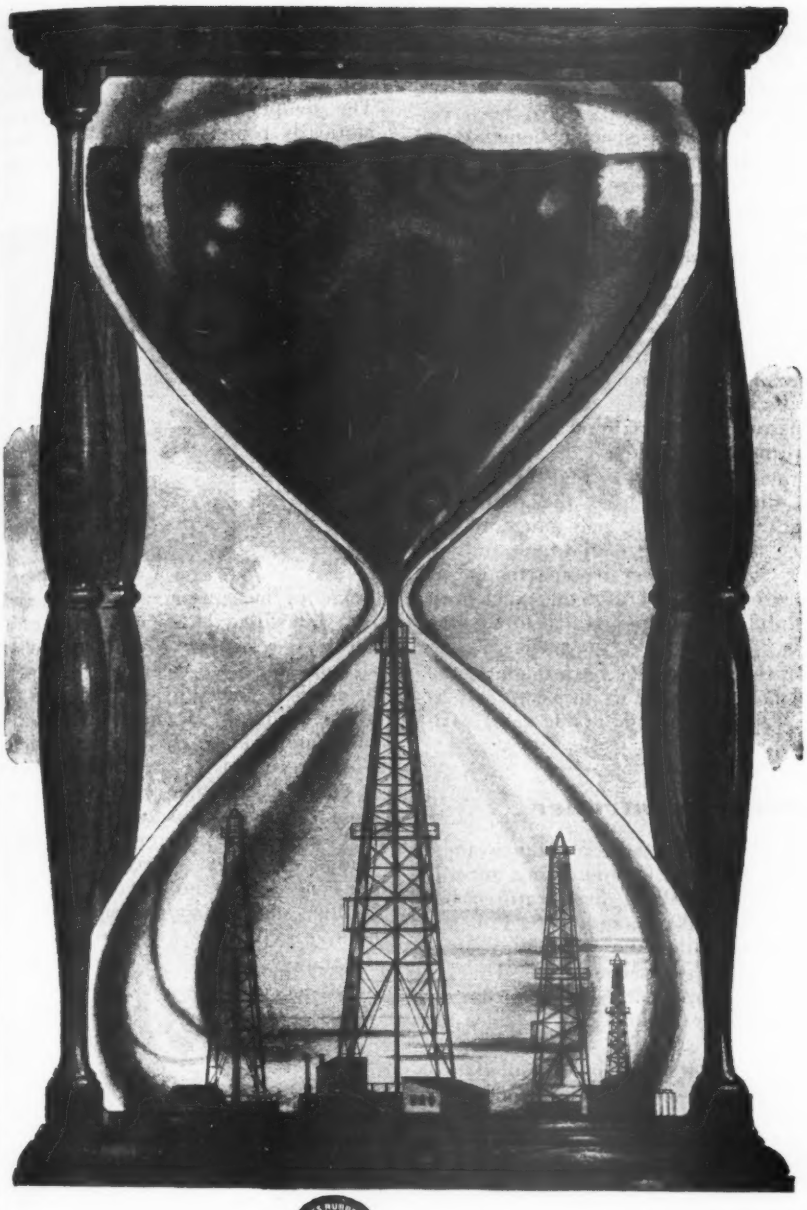
Standard equipment includes a cat-line sheave, built-in deadline anchor and ladders on both ginpole and mast. Optional equipment includes sandline sheave and crown safety platform. Unitized sectional steel substructures are available in 5 ft. 4 in. and 8 ft. 4 in. heights.

Emsco A-10 triplex slush pump.



Fuel oil clarifier

Briggs Clarifier Company, Washington 7, D. C., announces an improved standard line of round tank fuel oil filters for diesel engines. New models have been added to broaden the appli-



TIME SAVER FOR DRILLERS

Complete packing sets for oil field equipment come packaged and labelled under the "U.S." seal. Each label clearly indicates the names and sizes of equipment for which the set is intended. Shaft diameters and stuffing box depths have been checked in advance, and the individual items furnished to accurate measurements.

For busy operators this greatly simplifies the troublesome problem of ordering ...helps reduce the likelihood of delays caused by shortages of individual packing items... saves manpower.

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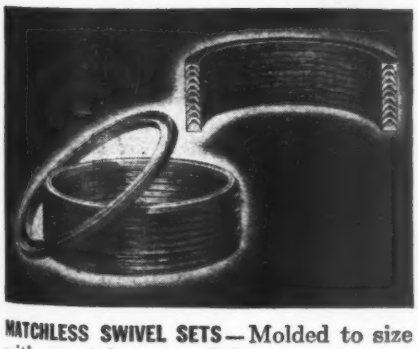
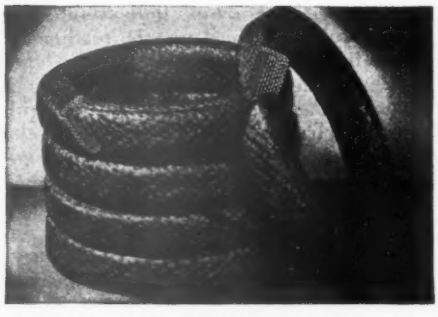
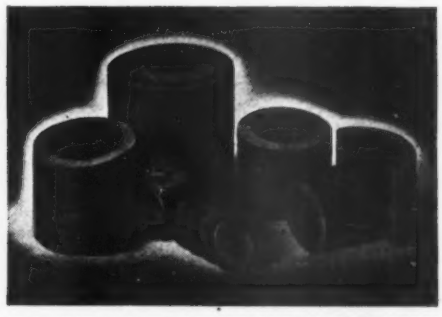


MATCHLESS SWIVEL SETS—Molded to size with special top and bottom rings to adapt packing to the stuffing box and gland. Entirely automatic in action. Another example of how U.S. Rubber engineering serves industry.



RAINBESTO HIGH-PRESSURE PACKING—For steam end of steam driven mud pumps and rotary boiler feed pump stuffing boxes. Selected asbestos cloth, with non-hardening cushion, treated with heat-resisting lubricants, graphite finish.



U. S. MUD PUMP SLEEVES AND SKIVED GLAND RINGS—Designed for use on fluid end of oil country mud pumps. Made from special U. S. compounds that resist the abrasion and pressures encountered in this type of service.

Listen to the Philharmonic-Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 E.W.T. Carl Van Doren and a guest star present an interlude of historical significance.

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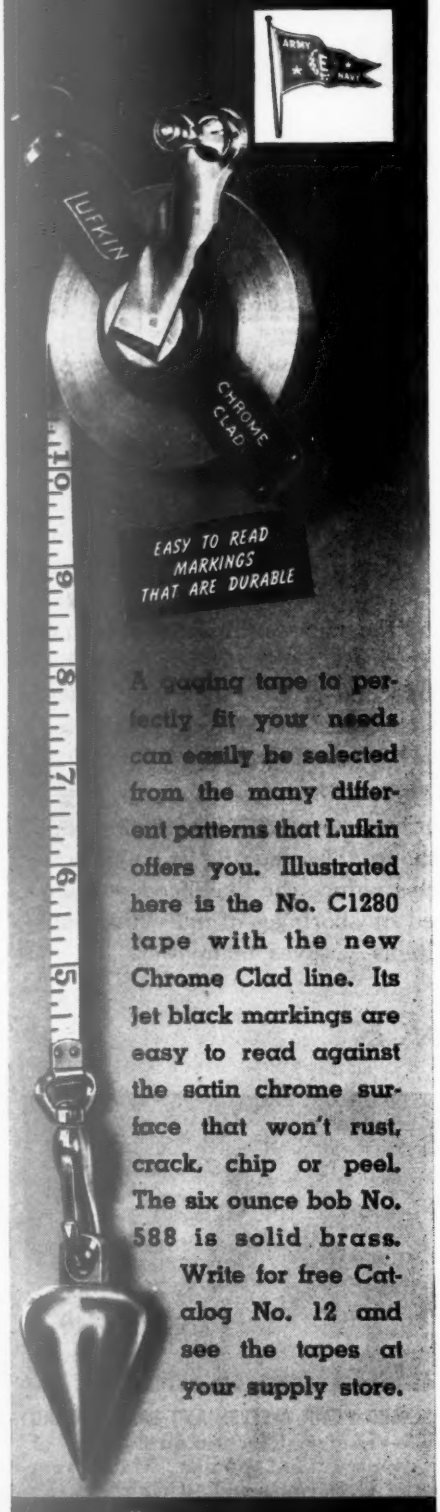

A gaging tape to perfectly fit your needs can easily be selected from the many different patterns that Lufkin offers you. Illustrated here is the No. C1280 tape with the new Chrome Clad line. Its jet black markings are easy to read against the satin chrome surface that won't rust, crack, chip or peel. The six ounce bob No. 588 is solid brass. Write for free Catalog No. 12 and see the tapes at your supply store.

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TAPES · RULES · PRECISION TOOLS

cation of Briggs Fuel Oil Clarifiers so that flow capacities range up to 500 gal. per hr.

Maximum working pressures and hydrostatic test pressures have been established to meet specific demands of the application. For small high speed diesel engines where pressures sometimes run well above 50 lb. per in., the clarifier is designed for a maximum working pressure of 100 lb. per sq. in., and is hydrostatically tested at 150 lb. per sq. in. For large, heavy duty diesels when pressure is usually between 15 and 25 lb., the clarifier is designed for a maximum working pressure of 40 lb. per sq. in. Pressure drop across the refills ranges from 0 to 50 lb. per sq. in. on all models.

Provision is made for registering pressure differential across the refill cartridges by installing one gauge in the upper compartment of the tank and another in the lower compartment. A glance tells the operator the exact pressure differential and when to change refills.

Improvements have been made in the refill holding assembly to assure a perfect seal at both ends of the refill cartridge.

Recorder-controller

An electronic type resistance thermometer suitable for indicating, recording, and controlling temperatures between minus 100 °F. and 1000 °F. is announced by Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio. This recorder operates on the highly accurate null balance principle and provides instantaneous balancing action by electronic detection and control. Unbalance of the measuring bridge is detected by electron tubes without the aid of a galvanometer or other moving parts. Reliable performance and accurate calibration over long periods of continuous operation are said to result from this sturdy design.

The recorder-controller illustrated in Fig. 1 indicates, records, and controls temperature. A 29-in. indicating scale that circles the chart may be read easily at a distance of 50 ft. The pointer reading coincides with that of the recording pen. Indicating, recording, and controlling mechanisms are all driven by the same reversible electric motor that adjusts the slidewire resistance to balance the measuring bridge. This motor is continuously connected to the electronic control unit, which in turn is continuously connected to the measuring bridge as shown in Fig. 2.

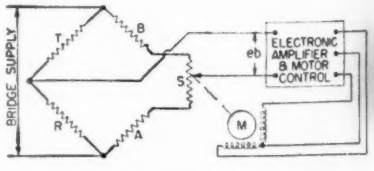
Bailey electronic resistance thermometers may be provided with as many as 4 recording pens, each one being provided with its own continuously connected electronic control unit and measuring bridge. This feature insures instantaneous response to changes in temperature.

The temperature sensitive element is a platinum resistance wire, wound on a mica form and held between two mica sheets that are clamped by a metal frame. The element is further protected by a well that is permanently installed in the pipe line, furnace wall, duct, or other point of temperature measurement. The temperature element is diagrammatically represented in Fig. 2. by the resistor T. Resistors R, A and B are fixed and are designed to provide proper

Fig. 1. Bailey electronic temperature recorder-controller.

range of measurement. Adjustment of the slidewire contact on the resistor S subtracts resistance from A and adds resistance to B or vice versa. Thus, the bridge is balanced by adjusting the ratio of the bridge arms and the necessity of carrying bridge current through the slidewire contact is avoided. Variations in contact resistance are thus prevented from affecting calibration.

As alternating current is used for the bridge, no battery source of bridge voltage is needed. Standard voltage cells and voltage standardization equipment are not required.



T=TEMPERATURE SENSITIVE PLATINUM RESISTANCE
A,B & R=FIXED RESISTORS M=SLIDEWIRE DRIVE MOTOR
S=SLIDEWIRE

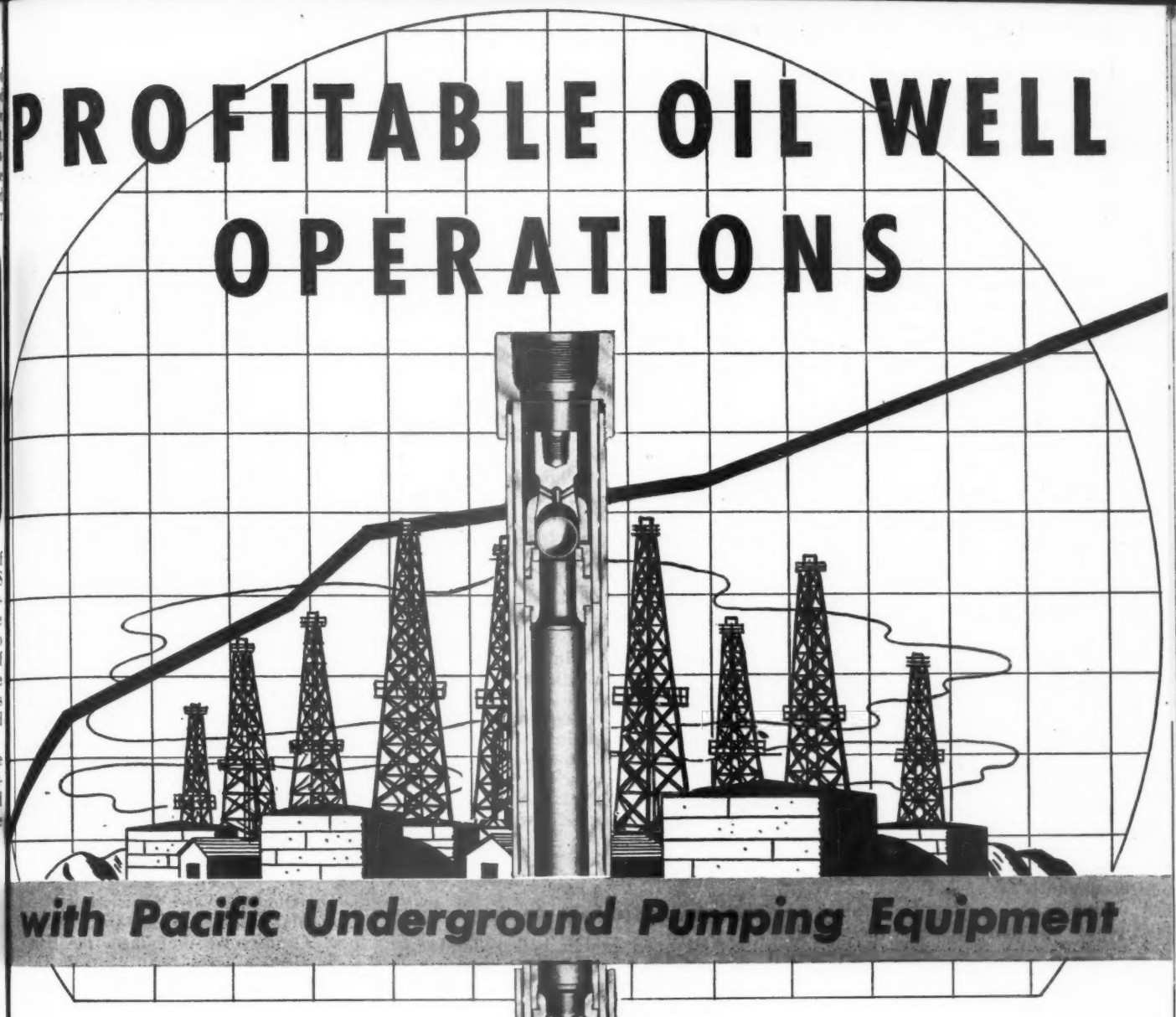
Fig. 2. Measuring circuit for temperature recorder-controller.

Bailey air-operated control, electronic control, or contacts for on-off electric control may be provided for as many as two temperatures by the multiple pen Bailey electronic recorder-controller. The control mechanisms required are mounted inside the recorder-controller casing and are actuated by the same reversible motors that drive the recording pens.

Alarm contacts may be provided for any or all of the recorder units. These contacts are operated by an adjustable cam that may be set to trip at any desired position of the recording pen.

Temperature measuring circuits may be arranged to calculate the sum, difference and ratio of temperatures. Calculated results are recorded directly by Bailey electronic type recorders in the form of news instead of history. Much time and labor may be saved by the electronic calculating method as compared with manual calculation from chart records and log sheets, the manufacturer asserts.

PROFITABLE OIL WELL OPERATIONS



with Pacific Underground Pumping Equipment

With "streamlined" cages and fittings, made of special Pacific Moloy metal, pumping efficiency is increased materially. Reduced fluid friction permits greater volume flow with less horsepower, less emulsion. Turbulence and ball spin are prevented.

Moloy metal allows closer tolerance, supplies double shock strength and reduces wear. Chrome-plated plungers and split-hair precision provide smooth operation. Liners and plungers can be reground three or four times. "Moloy," exclusive Pacific alloy, a product of Pacific research and development, reduces wear, tear and down time.

For full engineering data, write for illustrated catalog—or refer to Pacific's 24-page section in your 1944 Composite Catalog of Oil Field Equipment. Better yet, contact the Pacific field representative near you.

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Venturi-type safety valve

Farris Engineering Company, manufacturers of precision valve specialties, announces the development of a line of venturi-type safety valves with special provisions for constant accurate blow-off, exceptionally great capacity, complete tightness of re-seating, minimum escape of vapor into the surrounding space, and elimination of angular distortion and fouling.

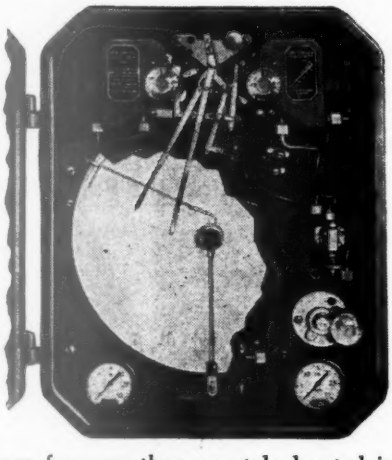
The inlet venturi tube nozzle of this design gives a clear unobstructed port and guided high velocity of the steam, which results in high lift and correspondingly great capacity, it is stated. One of the many outstanding features of these valves is the patented "separator bell." This device causes the steam to make three changes in direction before passing into the atmosphere, and includes a drain for the condensed moisture into the body. Escape of vapor into the air is thereby minimized. The "separator bell" also helps to keep the spring cool by preventing steam from striking the spring, and improves freedom and maintenance of alignment by providing for higher support of the spring, according to the manufacturer.

Correct alignment of the stem, on which complete tightness of re-seating depends, is further maintained by precision machine work throughout the valve, and by top guidance of the stem in two bearings. This two-bearing construction eliminates angular distortion, minimizes fouling of guiding areas, and provides maximum ease of maintenance besides assuring greatest accuracy of re-seating, it is asserted.

Further information concerning the design, ratings, and sizes of these safety valves can be obtained by addressing Farris Engineering Company, Palisades Park, New Jersey.

Pneumatic set controller

To provide a dependable controller whose control point, as indicated by a set pointer, would be automatically adjusted by variations in output air pressure from another remotely located instrument, which may be an indicator, recorder, or controller, the Pneumatic Set Controller has been developed by Taylor Instrument Companies, Rochester, New York, in both the indicating and recording forms. This controller is fundamentally a Fulscope controller with an additional unit to convert changes in input air pressure into linear movements of the set pointer. The magnitude of the linear set pointer movement per pound change in input air pressure is governed by the setting of the adjustment dial provided in this unit. The unit also provides for set pointer adjustments in either direction for an increase in input air pressure. and for limiting the travel of the set pointer within given limits. The instrument is also equipped with a manual set pointer adjustment feature.



The Pneumatic Set Controller has proved its versatility in a large variety of control applications where the set pointer of the controlling mechanism must be automatically and continuously adjusted in relation to variations in some other controlled or uncontrolled process variable. the manufacturer asserts. In the production of synthetic rubber it is being used to control the jacket water temperature of reactors to maintain constant product temperatures. It is also being used to control the speed of internal combustion engine driven air compressors to maintain constant suction or discharge pressures. In air conditioning work the Pneumatic Set Controller makes it possible to keep a fixed temperature ratio between outdoors and indoors, thus eliminating the shock that is experienced when there is too great a variation between the two. These are but a few of the applications to which the new highly versatile instrument can be used to advantage. Write to manufacturer for Bulletin No. 98158.

Flow splitting device

A new flow splitter, called the Micro-Rotawier, is available to divide a liquid flow into two streams. The proportions of the flow division may be varied at will by adjusting an outside lever and pointer to the percentage desired, as indicated by an external scale.

The operation of the Micro-Rotaweir is as follows: The inlet pipe comes in from the top and discharges the liquid into a receiving chamber that has a rectangular weir as an overflow. A vertical knife edge is set against the external edge of the weir, thus dividing the stream into two parts as it flows over the lip of the weir. One of the streams flows into a closed compartment with bottom outlet; the other stream spills into the area surrounding the receiving chamber and discharges also from the bottom. The receiving chamber is connected through a stuffingbox at the bottom to an external lever by means of which the weir may be rotated to any position with respect to the flow-dividing knife edge. A scale attached to the weir gives the liquid height above the weir lip so that total flow to the Rotaweir may be obtained.

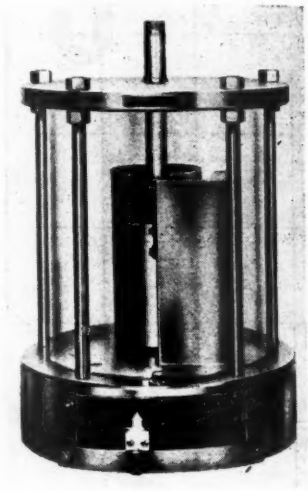
The Micro-weir may be obtained with fittings in all metals. The shell may be either metal or Pyrex glass. For high melting fluids the metal shell may be lagged and steamheating coils placed inside the Rotaweir.

The Micro-Rotaweir will handle flows from 30 to 900 gal. per hr. Sizes up to 15,000 gal. per hr. are also contemplated.

The Micro-Rotaweir has been used for the following operation:

(a) Proportioning product to reflux on small pilot plant stills.

(b) Dividing liquid flow to twin absorbing units, cooling towers, or other reactance vessels operating in parallel.



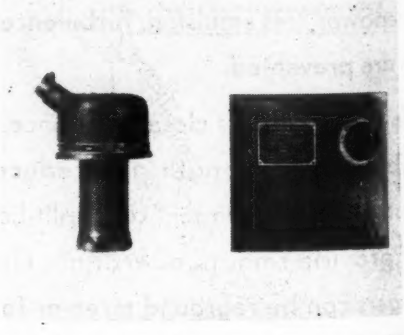
(c) Flow splitting for liquid blending and flows to storage tanks.

For complete information write to Fischer and Porter Company, 989 County Line Road, Hatboro, Pennsylvania.

Level float control

The Hancock Valve Division of Manning, Maxwell and Moore, Inc., Bridgeport, Connecticut, announces the Hancock electric level float control. The manufacturer states that this level control was designed by experienced engineers and gives accurate and dependable liquid level to within a fraction of an inch and is automatically and mechanically trouble free.

The company's new level control catalog states that the equipment is free from electrical switching or contacts within or without the float chamber. There are no levers, linkages, bellows, stuffingboxes, cooling fins, mercury switches, or wearing parts. By the simple adjusting of a screw the level of the liquid can be raised or lowered.



A complete illustrated and descriptive catalog of the Hancock level control will be sent upon request made to the manufacturer.

Line vibration caused by pulsating gas flow from compressors has always been a perplexing problem. Now . . . for the first time . . . *results can be pre-determined.* The Fluor Pulsation Dampener *positively* and *completely* stops vibration by converting the pulsating gas flow into a steady stream. The expensive practice of oversizing pipe lines merely to combat pulsation is no longer necessary. This means a tremendous saving . . . plus the elimination of trial-and-error procedure and resulting high maintenance cost due to failure of springs and other mechanical means commonly used to reduce line vibration. This positive protection can be used on both intake and discharge lines. Pressure drop is negligible. Designed for all operating pressures.

Patents Applied For

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PULSATION DAMPENER

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Dyna-Stat test pipe

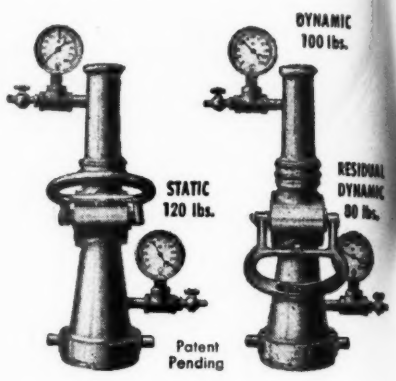
Important as the sphygmomanometer is to the physician for measuring blood pressure the Dyna-Stat hydrostatic-dynamic pressure test pipe is to the engineer for recording water pressure in pipe lines, hydrants, faucets, and pumpers — wherever proper water pressure is a vital factor.

This device goes an important step further than previous methods of recording water pressure, according to the manufacturer. Heretofore the common practice has been simply to connect a pressure gage to any water supply outlet. When the hydrant or valve was opened and the gage read, the results merely showed *static* pressure, not *dynamic* pressure.

Static pressure recordings do not give positive answers to what the water line tested would deliver through the outlet, it is asserted. Such readings are insufficient; they do not tell the whole story.

Dynamic pressure means the measure of power in a water stream in motion and gives the true and complete picture of how good or bad the available water supply actually is, or in what degree it is effective. This is definitely determined by the ratio of static to dynamic pressures.

The Dyna-Stat test pipe, a new product of Vulco Products Company, 409 West 36th Street, New York 18, New York, eliminates false conclusions by instantly and accurately recording the dynamic pressure, it is stated. With its help any ratio between static and dynamic pressures not within an acceptable range is immediately detected. The cause of the faulty flow may then be found and the trouble remedied.



It should be borne in mind that the Dyna-Stat test pipe itself does not cure faulty deliveries at fire hydrants and other outlets. It simply detects them, — makes the diagnosis, as it were, after which the cure may be effected promptly.

Besides its value as a means of fire protection, Dyna-Stat test pipes are used to advantage in many marine and industrial installations, in fact, wherever proper water pressure is a factor. The Vulco Products Company will gladly send to anyone interested a folder and easily understandable charts on this valuable new guesswork eliminator.

Synthetic resin

Monsanto Chemical Company, St. Louis, Missouri, announces that its technicians have perfected a new synthetic resin, which, when properly used in a low-pressure lamination process, will all but eliminate size as a restrictive factor in postwar plastics.

In effect, the company says, this means an entirely new field has been opened to the plastics fabricator, whose mass production output is now very largely limited to small items such as table radio cabinets, telephone cases, instrument housings, tablewear, compacts, and kindred small items.

To produce even these through existing compression or injection molding methods, fabricators must employ large and costly machines whose size and weight progress in geometric ratio to the size of the plastic object being manufactured. Molded items larger than 36 in. across, other than flat sheets or panels, are today virtually unknown.

In low-pressure lamination, heavy machines are not needed. Moreover, manufacture is simplified by the fact existing three-dimensional items may be used as forms or molds, and thus duplicated in plastic.

To produce a plastic bathtub, for illustration, the postwar fabricator will first make a textile coat to fit either the outer or inner dimensions of the mold, which in this instance might be a conventional bathtub. The textile coat then is impreg-

FOR THE BEST IN CABLE TOOLS

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FULL CIRCLE SLIP SOCKETS
(Fig. F482)
and
COMBINATION SOCKETS
(Fig. F497)

Spang Slip and Combination Sockets are rugged and tough. Room in the hole to add mass is limited, so Spang has substituted steel quality and heat treatment to give that extra strength needed to stand long heavy jarring when it is necessary.

They are carefully forged, thoroughly heat treated, and accurately machined. You can count on them!

Even a soft, simple fishing job can get tough and complicated. That's why it pays to always use only the best fishing tools for any fishing job. For the best in Cable Tools, SPECIFY SPANG.

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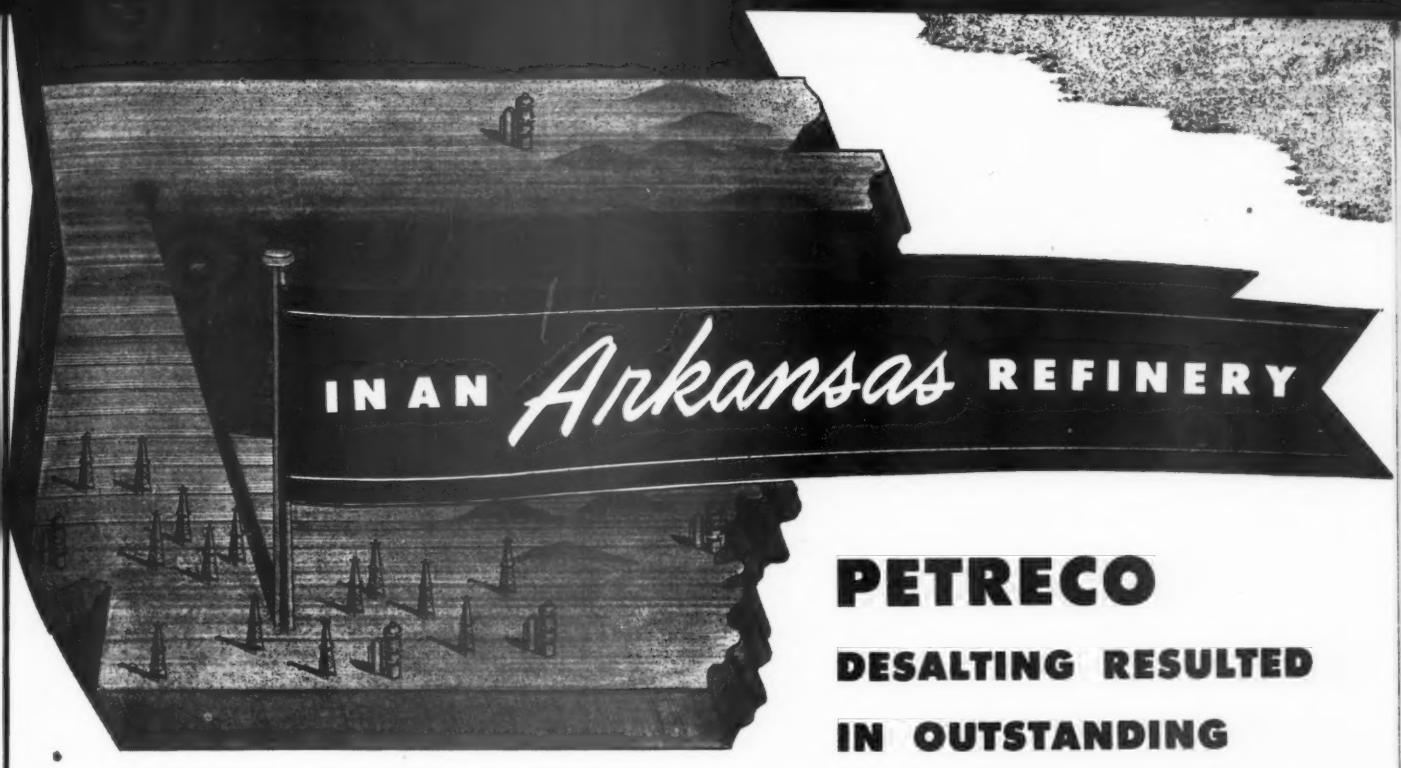

PETRECO

DESALTING RESULTED IN OUTSTANDING OPERATING IMPROVEMENTS

- ★ 86.6% Efficient Salt Removal (45 p t b to 6)
- ★ 900% Increase In On-Stream Time (3 days to 30)
- ★ Plugging due to salt eliminated
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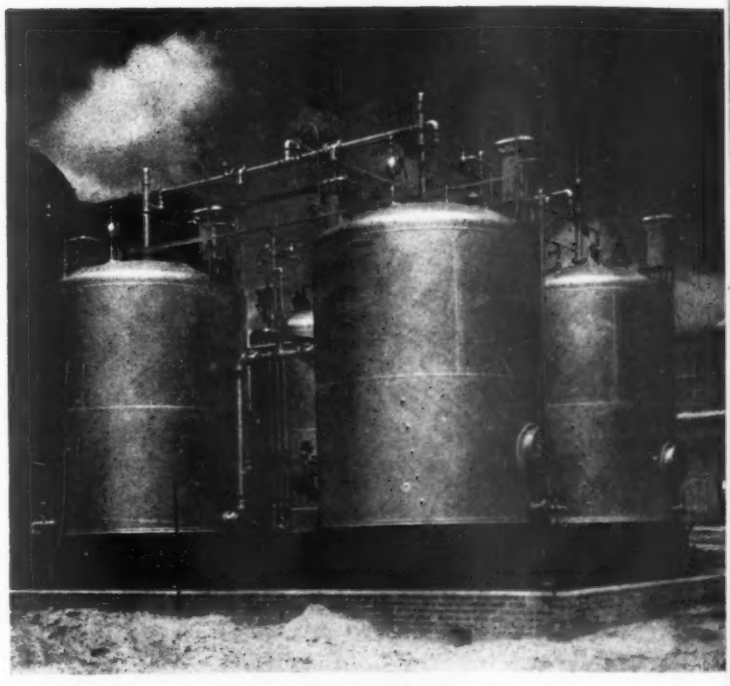
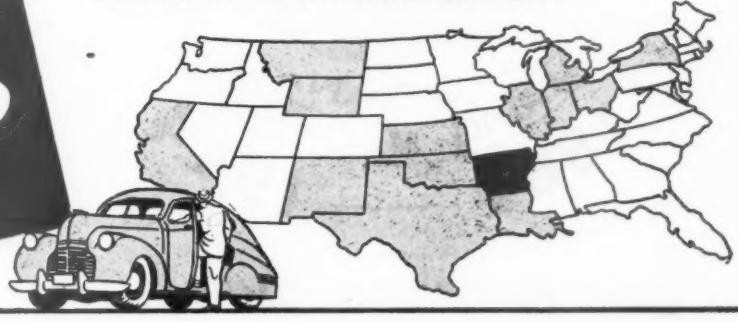
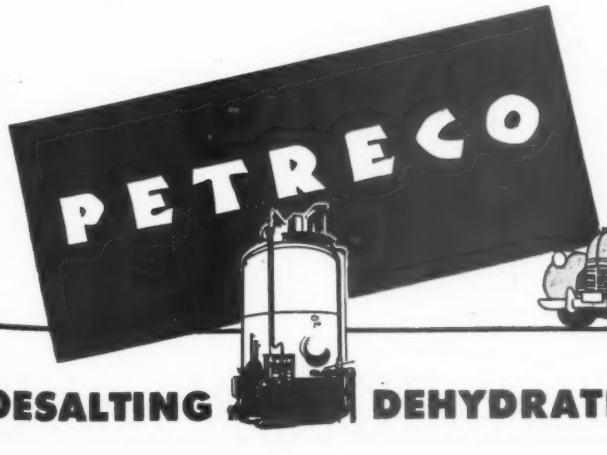
The experience of this Arkansas refiner is just one of many examples of improved refinery operations brought about by Petreco Desalting. In refineries all over America Petreco Desalting is repeatedly eliminating salt plugging, preventing scaling, reducing corrosion, improving products and increasing on-stream time. These are times when inefficiency cannot be tolerated...if your charging crude is salt-bearing in *any* degree, discuss the situation with a Petreco engineer. He can tell you the results Petreco is getting on similar salt contents.



COMPLETE U. S. OIL STATE COVERAGE





DESALTING DEHYDRATING

PETROLEUM RECTIFYING COMPANY

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530 West Sixth Street, Los Angeles 14, Calif.

Representatives in principal production and refining centers

nated with the resin, slipped on or into the mold, and baked for about 10 min. after the center of the laminate reaches the temperature of boiling water.

Because brightly-colored fabrics can be made to show through the transparent plastic, Monsanto sees an especially promising future for the new resin in luggage and trunks.

Other prospective uses already listed include curved wall panels, trailer bodies, specialty fenders, boats, toy wagons and bobsleds, curved furniture, machine housings, reusable crates and drums, vermin-proof chests and vaults, airplane sub-assemblies, and full sized radio and television cabinets.

The present output of the new resin is limited to military uses, most of which are of a secret nature, and for this reason is not available for evaluation on postwar applications.

Self-locking nut

A recently developed self-locking nut will soon be available to war industry, and engineers and designers working on postwar projects, according to William Dzus, president of the Dzus Fastener Company, Inc., Babylon, New York. Dzus, who also is the inventor of the Dzus spiral-slot cowl fastener.

The self-locking nut, he explains, eliminates all current difficulties in precision fastening as well as the need for accessories now used to keep the nut in place. No cotter pins or wiring are necessary, for example. In their place the nut itself has a feature that enables it to hold at any desired point.

This self-locking nut is all-metal. It does not jam the threads to fasten, and has full and undisturbed threads throughout the entire length of the nut, it is asserted.

It will maintain its locking features, Dzus asserts, regardless of the number of times it is screwed on and off, and the self-locking principle will not injure the thread of either the bolt or the nut.

The inventor termed this new invention the acme of simplicity plus strength, endurance, and safety, and stressed that in the very near future self-locking nuts will be available in standard sizes to war industries and engineers and designers working on postwar problems.

Aliphatic derivatives

New aliphatic compounds consisting of the even-numbered normal hydrocarbons from C_6 through C_{18} and the corresponding olefins, alcohols, ethers, mercaptans, thioethers, disulphides, and sulfonic acids have been developed by the chemical division of The Connecticut Hard Rubber Company, New Haven, Connecticut, as a result of research work in the synthetic rubber field. Most of these new chemicals are available in commercial quantities and are supplied in various grades from technical to "fine chemical."

The saturated n-alkanes are suggested for use as organic intermediates, laboratory solvents, and as standard hydrocarbons. The olefins, with the double bond at the first carbon, are interesting in organic synthesis, particularly as a starting material for dispersing agents, resins, oil additives, pharmaceuticals, and insecticides. Certain branch chain olefins, isomeric with the n-compounds of this series are available for laboratory research. The alcohols are also suggested as intermediates for chemical synthesis and for use in cosmetic preparations.

The aliphatic ethers are an interesting series that can be used as plasticizers, impregnating agents, solvents, heat transfer liquids, as well as in the cosmetic field.

The high-purity aliphatic mercaptans present possibilities as polymerization conditioners, intermediates for synthesis, corrosion inhibitors, oil additives, insecticides, flotation agents, and alarm odorants.

The thioethers and the disulphides are suggested for use as plasticizers, stabilizers, insecticides, oil additives, and flotation agents. The aliphatic sulfonic acids, available only in experimental quantities, are of interest as hydrogen soaps, and the salts as stabilizers, dispersing agents, wetting agents, and oil additives. The corresponding sulphones are available in limited amounts for experimental work.

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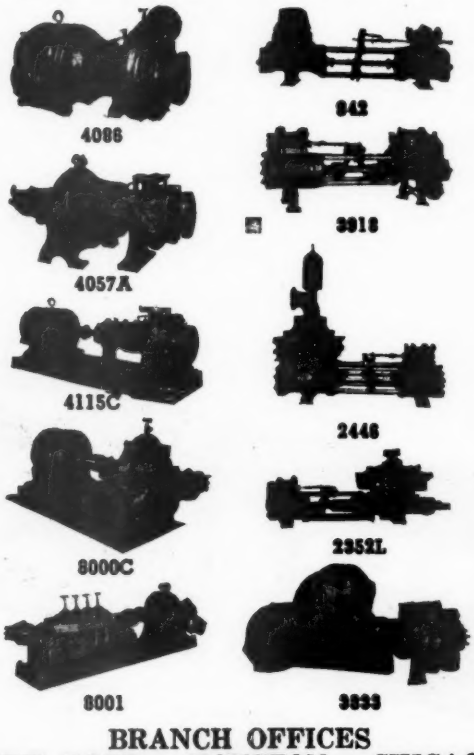

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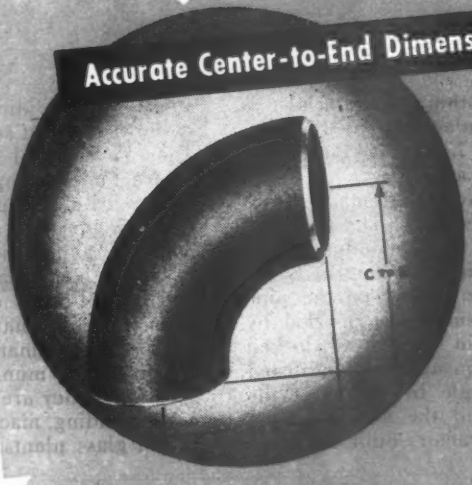
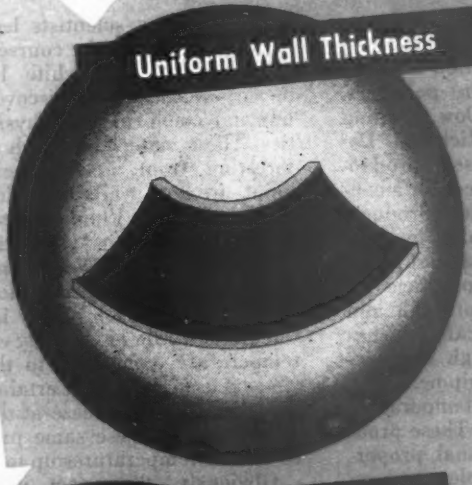
IMPORTANT FEATURES OF MIDWEST WELDING ELBOWS That Save Time and Money

Exact Included Angle

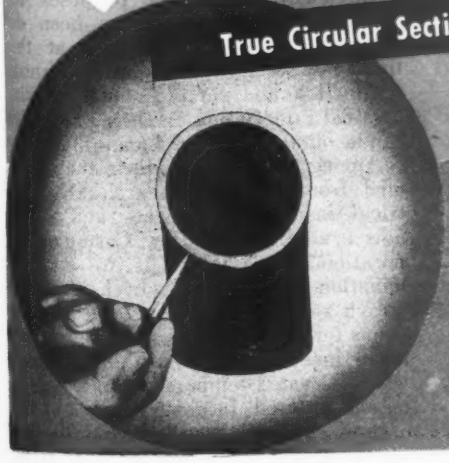
Accurate Center-to-End Dimensions



Uniform Wall Thickness



True Circular Section



Midwest Welding Elbows possess the features shown here to an unusual degree because of: (1) a unique manufacturing process whereby the final "size-forging" is in compression in totally enclosing dies that exactly control the metal distribution and (2) special machines for simultaneously machine-beveling both ends and holding the included angle within extremely close limits.

The importance of these features cannot be overemphasized . . . they simplify piping layout . . . they save time in lining up and welding . . . they permit better welds . . . they mean a better piping job.

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Main Office: 1450 South Second St., St. Louis 4, Mo.

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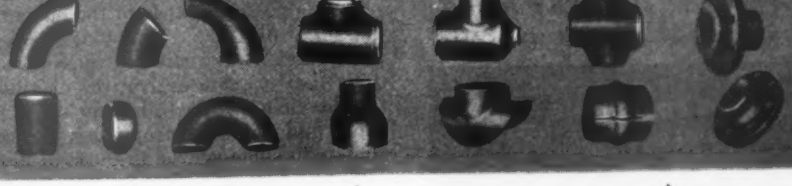
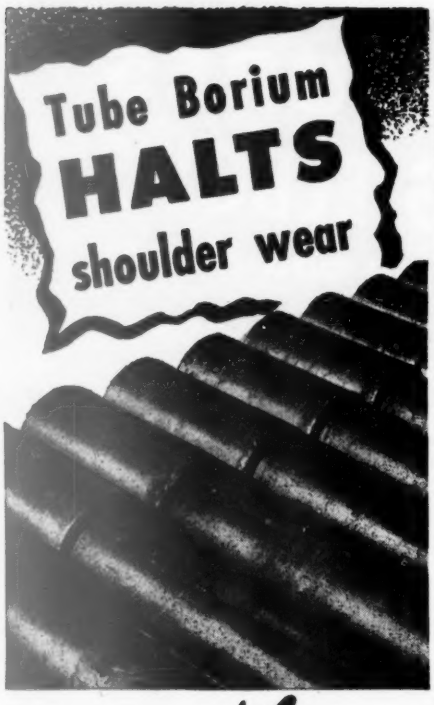
Distributors in Many Cities

MIDWEST WELDING FITTINGS IMPROVE DESIGN AND REDUCE PIPING COSTS





Doubles tool joint life

For fifteen years Tube Borium has been used on drilling bits to increase cutting speeds and drill more out-to-gauge hole. Now you can use this same alloy to greatly prolong the life of your tool joints!

An exceedingly small quantity of Tube Borium welded in a ring around the shoulder not only doubles tool joint life—even under the toughest operating conditions—but maintains over all joint strength and correct elevator contour. Applications are economically made on both new and resleeved joints.

APPLICATION: Accepted method of application is to under-cut new or resleeved joints at the shoulder to form a recess ⅛" deep by 1½" wide. The recess is then filled by welding in with ¾" Electric Tube Borium to form the wear resistant inlay.

Write for this special Stoody engineering bulletin describing in detail hard-facing procedures on tool joints—no obligation.

STOODY COMPANY
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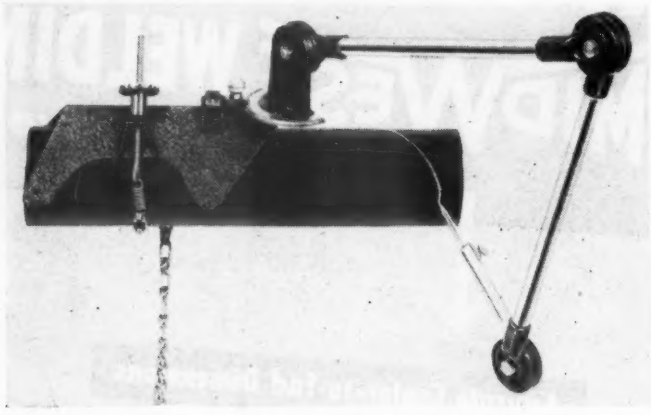
STOODY HARD-FACING ALLOYS
Retard wear... Save Repair

Trumark protractor.

Pipe, structural shapes, and flat sheets are quickly and accurately scribed for cutting on any angle to one-half of a degree with the Trumark protractor,



which, on allocation of materials, is again being manufactured by the Tru-Line Corporation, 759 Venice Boulevard, Los Angeles 15, California.

Trumark protractors are made in two stock models, three sizes. The model illustrated scribes the circumference of pipe 3 to 18 in. in diameter. In a few seconds it may be placed on the pipe parallel to the center line, leveled by means of a built-in spirit level, locked in place with a spring chain, adjusted to the desired angle by means of the 180-deg. scale, and the scribing completed. This protractor, built for hard service, is made of precision-machined cast-bronze alloy and steel tubing. The joints are large in diameter and contain special fiber bearings that hold the correct tension and maintain positive alignment. The marking arm is absolutely rigid throughout its travel. Another size of this model Trumark protractor marks pipe 12 to 36 in. in diameter.

Another model is the Junior Trumark protractor, which marks pipe or rod ½ in. to 3 in. in diameter. It is of sturdy die cast construction.

For use on flat surfaces, channel iron, T or I structural shapes, the Trumark protractor is set up as on pipe, or held square to any edge or corner. Plumb bob indicator and spirit level show any degree of angle from a horizontal plane.

Although elimination of wrap-arounds and complicated engineering calculations make Trumark protractors of especial time and material saving value for public utility, municipal and industrial field work, they are equally valuable for use in welding, machine and sheet metal shops, glass plants, and shipyards, etc.

Silicones

First commercial production of "Silicones," new organo-silicon polymers, has been announced by Dow Corning Corporation of Midland, Michigan. Development of silicones on a semi-production basis has been in progress for a considerable time. Several of these products are now being made available by Dow Corning for applications essential to the war effort. Dow Corning products include water white fluids for high and low temperature use, electrical varnishes and insulating resins for high temperature operating electrical equipment, and lubricating greases for high temperature and chemical resistant uses. These products, because of their unusual properties, have solved many problems where conventional materials have failed, the manufacturer asserts.

Dow Corning Corporation was formed in February, 1943, by Corning Glass Works and The Dow Chemical Company to manufacture and develop silicones more intensely. Corning Glass Works had been conducting research in organic derivatives of silicon for more than a decade. It is interesting to note that this early work was initiated by their research workers because of the advent of glass-like plastics. As glass is a silicon product, it was believed possible by them that organic derivatives of silicon should yield products having some unusual and valuable properties, perhaps similar in some degree to those of glass.

As so frequently occurs, the research of the Corning scientists led down unforeseen paths. In the course of their investigations water white liquid polymeric silicones were discovered having unusual chemical and physical properties. These materials, which are very interesting from an engineering standpoint, are now available under the name of Dow Corning Fluids. They are manufactured in various viscosities ranging from liquids as thin as water to those that barely flow at room temperature. Their outstanding property is an exceptionally low rate of viscosity change with temperature, compared to that of previously used liquids. Certain types are made that do not freeze at dry ice temperatures and these same products can be used at temperatures up to 400-500°F.

Obviously, the exact purposes for which these materials have been developed cannot be discussed at this time; however, they are now in quantity production and samples together with detailed information on their properties can be obtained from the manufacturer.

Among the other products that stemmed from Corning research are electrical insulating varnishes and resins now available from Dow Corning Corporation. These materials are the culmination of early efforts by Corning research workers to find suitable coating resins for use with glass textiles for electrical insulation or for other purposes where elevated temperatures are apt to be encountered. In general, none of the organic varnishes was substantially better, from the standpoint of heat resis-

Spreading cam is recessed in protected position at back of elevator.

Derrickman receives "AA" Elevator in level open position ready for quick easy action.

When opened, the BJ "AA" Elevator stays open—in level position, ready for the next stand. A cam and roller spreading device holds it open against closing action of the links. The elevator arrives at the fourble board in operating position. A quick pull or even the usual impact with the drill pipe frees the spreading cam. The elevator then swings easily to closed position.

Made of high alloy steel—fully heat treated—flame hardened on the top bore to minimize upsetting—this new BJ elevator is rated at 300 tons with a safety factor of four to one. Get the low-down on it from the BJ man or your supplier.

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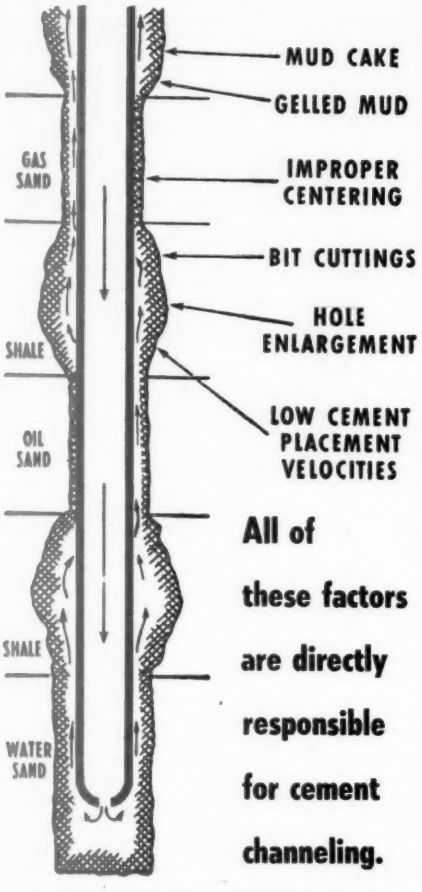
PREVENT
Channeling
WITH

B and W, Inc.
Wall Cleaning Guides



All of these factors are directly responsible for cement channeling.

Placement of B & W Wall Cleaning Guides at 5-foot centers on your casing throughout the productive sand sections, coupled with movement of the casing during the cementing operation, provides good cement CONTACT and a good completion.

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Houston, Texas • Phone: Preston 9783

tance, than the cotton or paper usually used in elctrical windings. Hence there was a definite need for resinous dielectrics that would not decompose and carbonize when electrical equipment was overheated.

Dow Corning silicone resins for electrical insulation extend the range of operating temperatures possible in electrical equipment beyond the limit of thermal stability of conventional organic materials. One of the resins is available as a coating and impregnating varnish that may be applied to Fiberglas cloth, asbestos cloth, asbestos paper and Fiberglas served wire or the like by conventional dipping and drying methods. It requires baking at a temperature of 250°C. for one to three hours to cure to a non-tacky state. Another is an impregnating varnish that sets with heat at 200°C. These materials do not carbonize or darken when subjected to prolonged heating at the curing temperatures. In combination with Fiberglas, asbestos and mica, these Dow Corning impregnating and coating resins permit the design of many types of electrical equipment for higher safe operating temperatures with consequent increase in capacity, reliability, and life performance, it is stated.

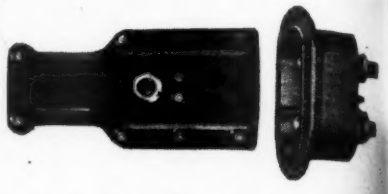
Electrical connector

The adaptation of the modified aircraft battery starting connector to oil-field gas pumping engines has been established in several Pacific Coast and Mid-Continent oil fields where, according to the manufacturer, considerable savings in time, engine parts, and batteries have resulted. The coupling equipment requires the receptacle portion of the connector to be mounted on the engine frame adjacent to the carburetor. A movable plug attached to cable connected with a battery or a generator on the mobile service truck completes the equipment.

The demand for such a fitting had grown out of the difficulties and problems in maintaining field batteries, generators, solenoids, push buttons and other items incidental to engine starting equipment for oil-field pumping as well as drilling units.

Various means of starting oil-field gas engines are in use today including batteries connected to generators, similar to that found in the average automobile and are familiar to all oil-field men. Others include hand cranking and crude connecting devices in conjunction with batteries mounted on mobile service trucks. No matter which of these means is used, maintenance problems are many and complicated, such as upkeep of batteries on the engine; burned-out generators as a result of failure of cutoff; stolen batteries in isolated fields; time-consuming factors in starting operations; hazard to life and limb in hand cranking of engines.

The receptacle here described is manufactured by Cannon Electric Development Company, Los Angeles, Calif. It has two 150-amp. pin contacts, positive and negative, and a third 40-amp. contact, which are mounted on the engine frame. Contacts having 600-amp. in a slightly different plug shell will be available soon. The plug has three corresponding socket contacts and is a cord plug attached to the battery carried in the service truck. Connection is made easily and quickly. The circuit is operated by a push-button that is an integral part of the plug, allowing the service



man's other hand to be free to adjust the choke in engine starting. No batteries or generators are needed on the engine. A magneto ignition suffices.

If the separate push button is desired, a connector with only two contacts is available. The receptacle is set flush with the engine frame panel, thus avoiding any protruding parts that might be easily damaged. Shell material of the receptacle is aluminum alloy with sand blast and clear lacquer finish. Contacts are brass, silver plated. The 150-amp. socket contacts accommodate No. 0 B&S stranded wire, 600-amp. contacts accommodate No. 00 wire, and 40-amp, contact No. 10 B&S stranded wire. The millivolt drop is slight.

The plug shell is phenolic (linen bakelite) made in two parts and held together by screws. This splitshell construction makes it possible to replace or repair the socket contacts easily.

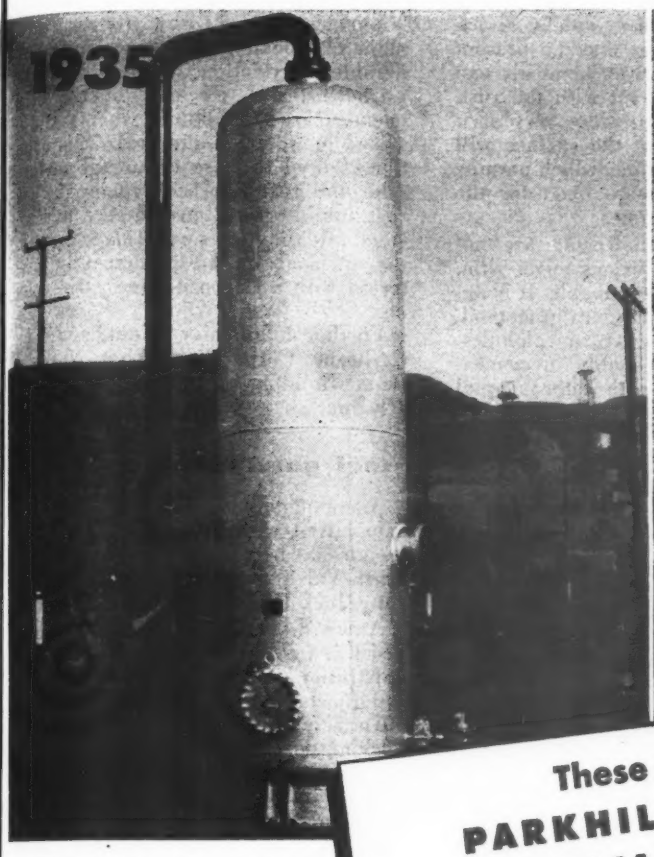
The installation of the connector receptacle on the engine in the field is simple. After laying out the position selected for the receptacle adjacent to the carburetor, a 7/8-in. hole is drilled through the panel on the frame. A heavily threaded screw is put through the hole and die and large nut attached. A long handle wrench requires very little turning to apply sufficient force so that the die will cut through the plate. The washer is then removed and the receptacle shell inserted. The mounting hole is drilled using the shell as a positioning guide.

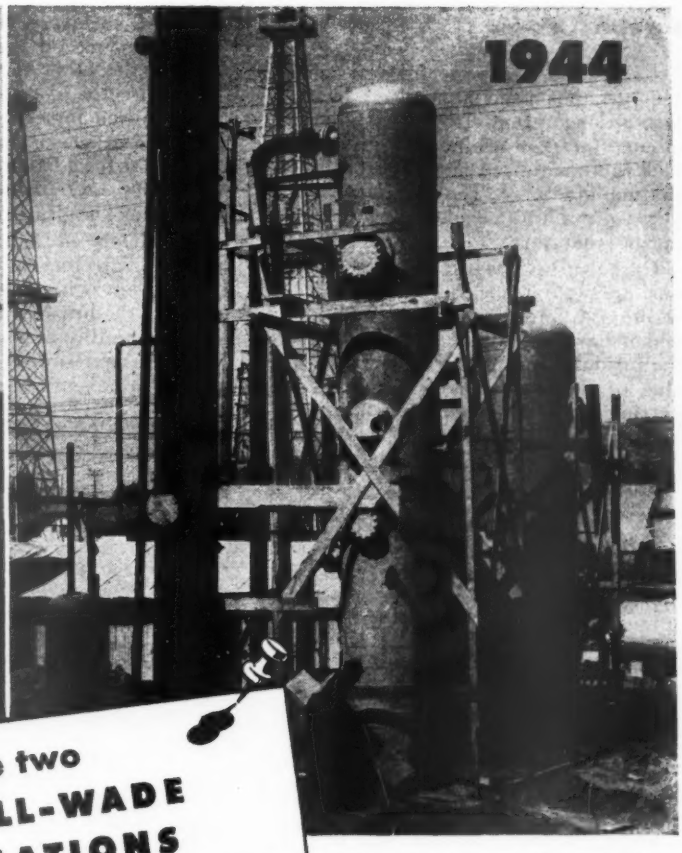
Pressure gages

New spring and bellows actuated pressure gages that measure ranges between zero and 5 in., and zero and 50 in. of water, are being made available for industry by the Brown Instrument Company, Philadelphia precision industrial instrument division of Minneapolis-Honeywell Regulator Company.

Two new types of gages are being introduced, according to the Brown company announcement. One gage has a single spring for pressure ranges. The other has a second spring, in tandem with the first, for vacuum and compound ranges.

The new models are said to be possible for many applications. These include combustion pressures and steel, petroleum, chemical and aviation engine manufacturing, processing and testing.





Original Calcium Chloride Dehydration Plant designed and constructed by Parkhill-Wade in 1935 for one of the large California utilities. The most advanced gas dehydrator of its type at that time.

These two PARKHILL-WADE INSTALLATIONS represent 9 years' improvement in gas dehydration!

New Diethylene Glycol Dehydration Plant just completed by Parkhill-Wade for the same company, in the same field. Circuit and process use latest developments available in gas dehydrating technique.

IN 1935, the calcium chloride dehydration unit shown at left above was designed and built by Parkhill-Wade and installed for one of the largest gas companies in California. The second unit of its kind in the United States, *it represented at that time the most advanced development in gas dehydration technique!*

But at right is the new Diethylene Glycol Dehydration Plant just completed by Parkhill-Wade for the *same* company—in the *same* field—and installed next to the original brine unit. Constructed to handle 50,000,000 cubic feet of gas per day at 400 pounds pressure, this new plant is the very *latest* advancement in dehydrating operations, incorporating many important new features. Conversion to diethylene glycol called only for an additional contactor, diethylene glycol rectifier, heat exchanger and control equipment.

▶ *The process and circuit used—the result of Henry N. Wade's developments in gas dehydration—provide greatly improved results over the original calcium chloride . . . in higher water removing efficiency . . . elimination of corrosion . . . lowering of dewpoint . . . and simplification of equipment needs.*

This is only one example of Parkhill-Wade engineering ability in gas processing. Before you install *any* gas handling equipment, it will pay you to investigate the many outstanding Parkhill-Wade developments in gas plant and pipeline design. Our engineering staff will be glad to provide you with further details on these advancements.

Parkhill-Wade engineers and designs equipment of all kinds for large-scale processing of the lighter hydrocarbons. We will be glad to make recommendations—or work with you toward solution of special engineering problems. Write—briefly outlining your requirements.

Parkhill and Wade — *Parkhill-Wade*

CarboRustex

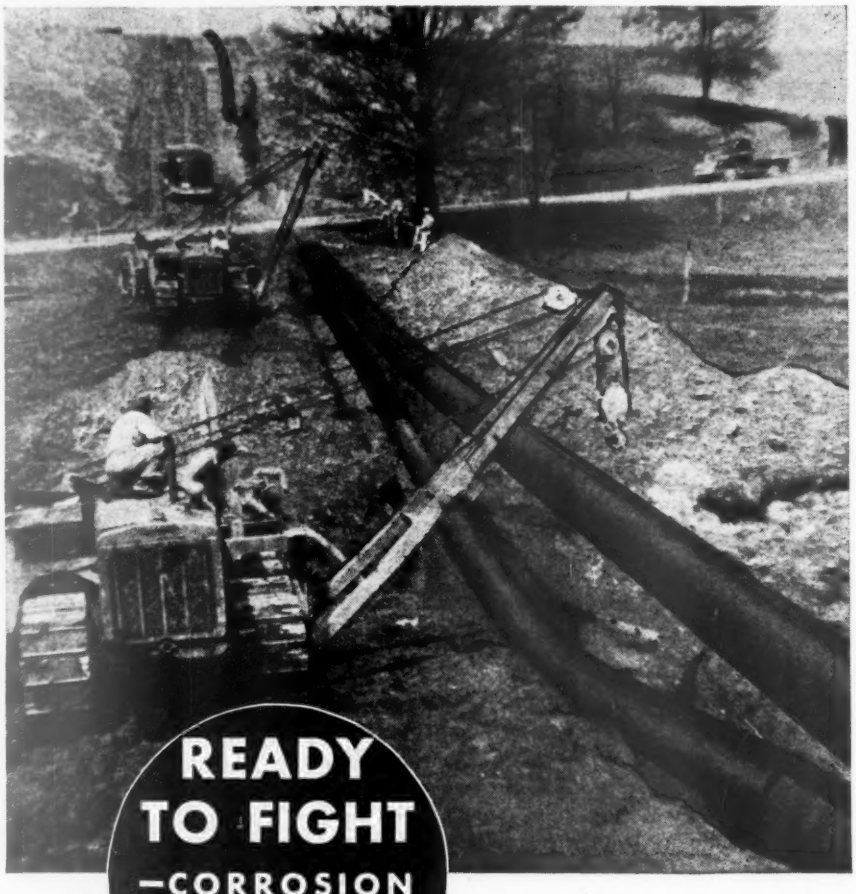
CarboRustex, a powerful new solvent for rust, has been announced by Carbozite Corporation. CarboRustex has an affinity for rust itself, but will not attack the unoxidized metal, according to the manufacturer. The formula for the new solvent was developed in the Carbozite laboratory.

CarboRustex is not composed of only one or two chemicals, but consists of several different chemicals, each of which has its individual reaction upon the various conditions of rusted surfaces. One of these chemicals assists in dispersing the active ingredients uniformly over the surface. Others chiefly attack any grease or oil that may be present so that the other active chemicals can come directly in contact with the rust. Most of the ingredients are very slow in evaporation so that the surface will stay moist for a long time, which permits the active ingredients to react for the maximum length of time.

Chemicals in CarboRustex are not toxic nor are they injurious to the skin. The solvent is non-inflammable. It is applied by the brush, spray, or dip method, spreads readily and leaves no globules. CarboRustex, supplied only in concentrated form, is mixed with water in equal parts.

Surfaces treated with CarboRustex remain chemically clean, and quite vulnerable to oxidation. With shipments of CarboRustex a sufficient quantity of a chemical rust inhibitor, which is dissolved in water, is supplied. This solution is used to rinse the metal surface after the rust has been removed. The rust inhibitor will protect the surface from oxidation for several days or until the surface can be permanently protected with a Carbozite protective coating.

Further details may be obtained from Carbozite Corporation, First National Bank Building, Pittsburgh 22, Pennsylvania.



READY TO FIGHT —CORROSION ABRASION SOIL STRESS

because it is Dependably Protected with REILLY ENAMEL

Reilly COAL TAR PRODUCTS

17 PLANTS to Serve the Nation

★ Corrosive agencies wage constant warfare on steel pipe from the moment it goes into the ground. REILLY Enamel gives pipe a tough, durable coating that seals the steel against these corrosive agencies and enables it to withstand all deteriorating influences of soil and climate. The results are longer life, lower maintenance costs, fewer service interruptions.

Booklet describing REILLY Protective Coatings for all industrial applications will be sent on request.

REILLY TAR & CHEMICAL CORPORATION

Merchants Bank Bldg., Indianapolis 4, Ind.

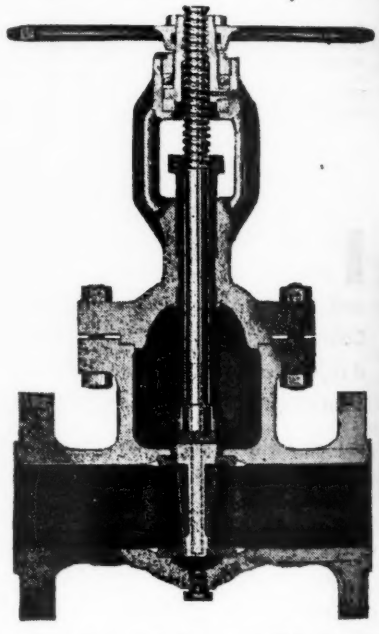
500 Fifth Ave., New York 18, N.Y. • 2513 S. Damen Ave., Chicago 8, Ill. • Architects Bldg., Los Angeles, Calif.

Steel gate valves

A completely new line of cast steel gate valves, with basic improvements in design, has been introduced by The Edward Valve and Manufacturing Company, Inc., East Chicago, Indiana.

A new Edward gate valve catalog No. 12-E1 is just off the press and includes illustrations, complete details of design, and dimensional data.

To achieve perfect alignment of all working parts, close fitting wedge guide ribs are constructed by a new method that eliminates unnecessary and wear-producing drag across seating faces.



Seat rings of the new Edward gate valves are hard surfaced and welded integrally to the body. Specially built fixtures permit hydrostatic test of both seating faces simultaneously, in contrast with the customary procedure of testing one face at a time. All Edward gate valves 4 in. and larger are equipped with ball bearings. In the smaller size bearing plates for yoke bushings are EValized, a special Edward plating process, to reduce operating effort.

The new Edward gate valves are being built in 300, 600, 900, and 1500 lb. sp. classes and in sizes 2½ to 12 in., inclusive. They are available in some sizes and pressure classes for immediate shipment out of stock.

effective and fast—keeps gravity high, volume loss low

When it comes to treating "cut oil" with speed and efficiency, Tret-O-lite is the choice of most of the world's oil producers. When the familiar red drums of Tret-O-lite go on duty, three things occur — gravity is kept *high,* volume loss *low* and costs go *down.* Service starts when the capable Tret-O-lite field engineer goes on the job. There is one located near you. Let him make tests and recommend the correct compounds for your particular needs.

TRETOLITE COMPANY *Manufacturing Chemists*
Webster Groves, St. Louis Co., Mo. · Los Angeles, Cal.

Say "DOUBLE E"
WHEN YOU WANT . . . . The Best

TUBING CATCHER

The outstanding advantage of the DOUBLE E Multiple Step Tubing Catcher is that it protects the tubing without distorting the casing. This is accomplished by the multiple step design, which permits an extra large gripping surface, distrbuting the load over a much greater area than other catchers. Note the illustration at left. The simplicity of design and the heavily sectioned parts of this tubing catcher naturally are points of importance in provding long and economical life.

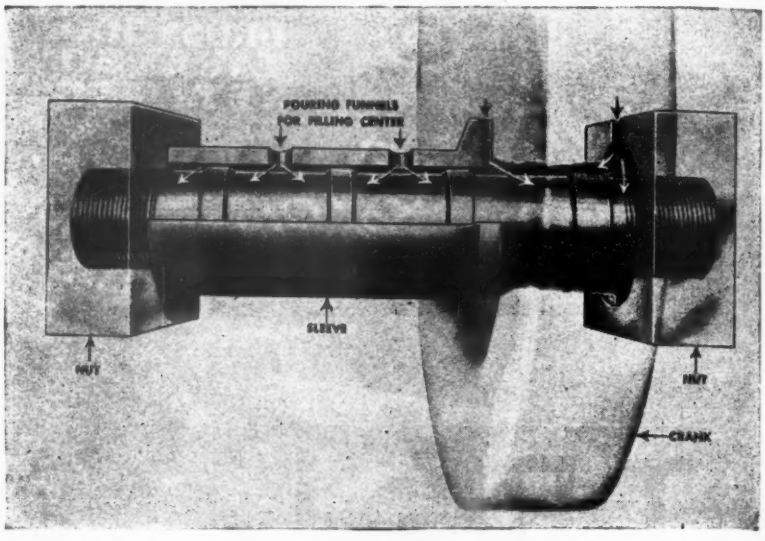
Tubing Catchers can be supplied with or without anchors. The anchors can be furnished for left-set or right-set, as desired.

"DOUBLE E" Products
EQUIPMENT ENGINEERS
INCORPORATED
2039 AMELIA STREET
DALLAS 9, TEXAS

Sleeve flange crank pin

For emergency and permanent use, a rugged and effective replacement crank pin has been designed for pumping oil wells. Known as the Heaston sleeve flange crank pin, this new pin makes it possible to renew crank or wrist pins without shutting down the well for hours or days, irrespective of how badly broken the hole in the crank appears to be.

This crank pin consists of a special grooved pin, flanged sleeve and two nuts. No prior experience is needed to install it. The old worn-out pin is removed and the new pin inserted in the crank. The sleeve is then slipped over the pin and the nuts screwed on. A quick preheating job completes the operation. This simple procedure makes a rigid installation that will outlast the original pin and give permanent service.



George H. Stoddard, who years ago founded the distributing firm of Buck and Stoddard, is placing the pin on the market. Literature may be obtained by writing to him, Richfield Building, Los Angeles 13, California.

Multiple cartridge purifier

Honan-Crane "M" type purifiers are designed to use single or multiple cartridges in standard groupings of 1, 3, 4, 6, 8, 10, 14, 18, 20, 24, and 38, according to the capacity needed.

Some of the outstanding features include: High flow rate, cartridge type refill elements are used in standard size 7 5/16 by 18, direct connected or bulk station use, uses either fuller's earth or navy type cotton waste cartridges, uses cartridges easy to remove and replace, cartridge when loaded with contamination weighs approximately 30 lb. and is easy to lift from purifier, double decking of two cartridges saves valuable floor space, operation of purifier with exception of changing cartridges is entirely automatic and does not require additional labor to operate, necessary heat can be supplied by either electric heater bands, water or steam, entire unit is compact and takes up very little floor space, pump and motor can be mounted in base.

Several recent changes in engineering design have greatly simplified the changing of cartridges in these purifiers. Cartridges can be removed by turning knob, which unlocks the handle from the center tube. The handle is lifted off and cartridges are easy to lift off the center tube. New cartridges are slipped on the center tube and handle locks in position. The spring on handle securely holds cartridges in position.

Honan-Crane Corporation, 114 South Street, Lebanon, Indiana, is the manufacturer.

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 90

A VALUABLE and regular feature of *The Petroleum Engineer,* the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.* Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue, and 86-88, inclusive, in the October, 1944, issue.

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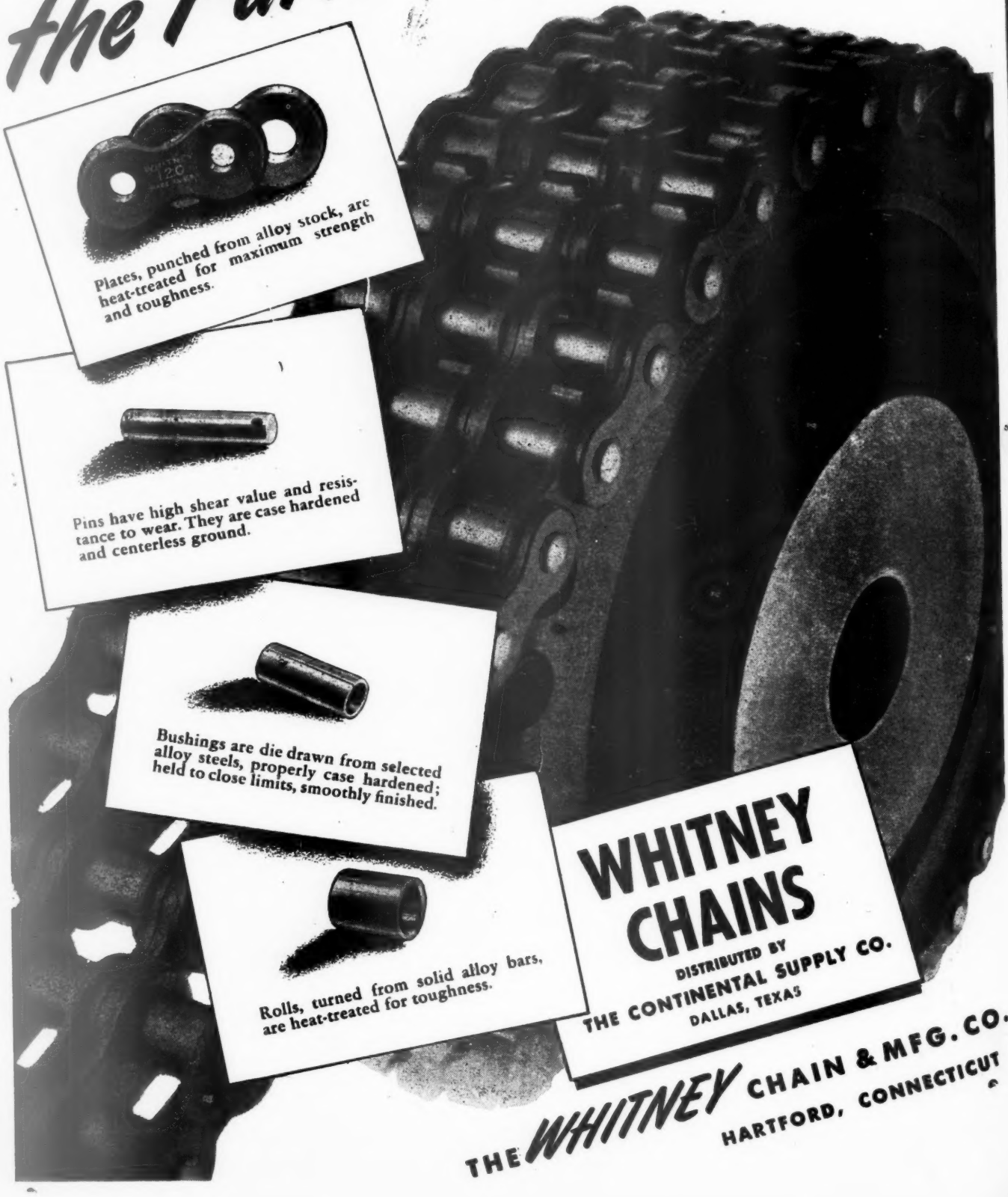
The Proof is in the Parts

Whitney Roller Chains are built to give positive, powerful performance in the constant service demanded by wartime schedules. Every part may be relied upon to do its part.



Plates, punched from alloy stock, are heat-treated for maximum strength and toughness.

Pins have high shear value and resistance to wear. They are case hardened and centerless ground.

Bushings are die drawn from selected alloy steels, properly case hardened; held to close limits, smoothly finished.

Rolls, turned from solid alloy bars, are heat-treated for toughness.

WHITNEY CHAINS

DISTRIBUTED BY
THE CONTINENTAL SUPPLY CO.
DALLAS, TEXAS

THE WHITNEY CHAIN & MFG. CO.
HARTFORD, CONNECTICUT

HYDROCARBON AZEOTROPES

AROMATICS—Continued

BENZENE—Continued (80.2°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Isopropyl acetate	90.8	No	..	1
Isobutyl bromide	91.6	No	..	1
Methyl isobutyrate	92.5	No	..	1
Methylisopropyl ketone	95.4	No	..	1
Allyl alcohol	97.0	76.8	82.6	3
n-Propyl alcohol	97.2	77.1	83.1	3
Isoamyl nitrite	97.2	No	..	1
Isobutyl formate	98.2	No	..	1
sec-Butyl alcohol	99.6	79.0	..	1
Formic acid	100.7	71.1	69	1
Nitromethane	101.5	79.2	88.7	3
Propyl acetate	101.6	No	..	1
Dimethylethyl carbinol	102.0	No	..	1
Crotonaldehyde	102.2	No	..	1
Diethyl ketone	102.2	No	..	1
Acetal	104.5	No	..	1
Isobutyl alcohol	107.9	79.8	90.7	1
n-Butyl alcohol	116.9	No	..	1
Acetic acid	118.5	80.1	98	1
Isoamyl alcohol	130.5	No	..	4
Chlorobenzene	131.8	No	..	4
Propionic acid	140.7	No	..	1
Isobutyric acid	154.4	No	..	1
Bromobenzene	156.1	No	..	4
Cyclohexanol	160.7	No	..	1

TOLUENE (110.7°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Chloroform	61.2	No	..	4
Methyl alcohol	64.8	63.8	31	2
Carbontetrachloride	76.8	No	..	4
Ethyl alcohol	78.3	76.7	31.9	3
Methylethyl ketone	79.6	No	..	1
Isopropyl alcohol	82.3	80.6	42.1	3
Isopropyl alcohol	82.3	No	..	4
Dichloroethylene	83.7	No	..	1
Ethyl nitrate	87.7	No	..	1
Allyl alcohol	96.5	92.4	49.8	3
n-Propyl alcohol	97.2	92.6	57.2	3
Isoamyl nitrite	97.2	No	..	1
Chloral	97.8	No	..	2
Isobutyl formate	98.2	No	..	1
Ethyl propionate	99.2	No	..	1
Formic acid	100.7	85.8	50	1
Nitromethane	101.0	95.0	..	16
Propyl acetate	101.6	No	..	1
Dimethylethyl carbinol	102.0	99.2	..	1
Crotonaldehyde	102.2	101.0	..	1
Diethyl ketone	102.2	No	..	1
Methyl n-propyl ketone	102.3	No	..	1
Propyl iodide	102.4	No	..	1
Methyl butyrate	102.7	No	..	1
Piperidine	105.7	No	..	1
Isobutyl alcohol	107.9	101.2	55.4	3
Ethyl isobutyrate	110.1	109.8	..	1
Chloropicrin	111.9	109.0	..	1
Stannic chloride	113.9	109.2	48	1
Pyridine	115.5	No	..	1
Epichlorohydrin	116.5	108.4	71	2
Methyl isovalerate	116.5	No	..	1
Isobutyl acetate	117.2	No	..	1
n-Butyl alcohol	117.7	105.5	67.9	3
Acetic acid	118.5	105.4	64	1
Ethyl borate	118.6	No	..	1
Isobutyl iodide	120.0	No	..	1
Isoamyl bromide	120.2	No	..	1

TOLUENE (110.7°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Ethyl butyrate	121.5	No	..	1
Propyl propionate	122.5	No	..	1
Isoamyl formate	123.8	No	..	1
Paraldehyde	124.0	No	..	1
Ethyl carbonate	125.9	No	..	1
Isoamyl alcohol	129.3	No	..	1
Mesityl oxide	129.5	No	..	1
Chloromethyl acetate	129.5	No	..	1
Amyl bromide	130.0	No	..	4
Isobutyl carbinol	131.3	110.1	86	2
Chlorobenzene	131.8	No	..	4
Acetylacetone	137.7	No	..	2
Propionic acid	140.7	No	..	1
Methyl lactate	143.8	110.4	82	2
Isobutyric acid	154.4	No	..	1
Bromobenzene	156.1	No	..	4
Cyclohexanol	160.5	No	..	1
Butyric acid	163.5	No	..	1

ETHYLBENZENE (136.1°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
n-Propyl alcohol	97.2	No	..	1
Formic acid	100.7	94.0	32	1
Formic acid	100.7	99.5	3	1
Isobutyl alcohol	108.0	107.4	>20	2
Epichlorohydrin	116.5	No	..	1
n-Butyl alcohol	116.9	115.0	..	1
Acetic acid	118.5	114.7	34	1
Propyl propionate	122.5	No	..	1
Isoamyl formate	123.8	No	..	1
Paraldehyde	124.0	No	..	1
Butyl acetate	125.8	No	..	1
Ethyl carbonate	126.0	124.0	23	1
Ethyl carbonate	126.0	No	..	1
Isoamyl alcohol	130.5	125.9	50.7	3
Mesityl oxide	130.5	No	..	1
Ethylene bromide	131.5	131.1	10	1
Ethylene bromide	131.5	131.1	53.6	3
Chlorobenzene	131.8	No	..	1
Ethyl isovalerate	134.5	No	..	1
Isobutyl propionate	136.9	133.0	52.1	3
Acetylacetone	137.7	135.0	65	1
Propionic acid	140.7	131.1	72	1
1, 2-Dibromopropane	141.6	136.0	95.1	3
Isoamyl acetate	142.1	No	..	1
Butyl ether	142.2	No	..	1
n-Dipropyl ketone	143.6	No	..	1
Isobutyric acid	154.4	131.9	82	1
Isobutyric acid	154.4	134.3	88	1
Bromobenzene	156.1	No	..	1
n-Butyric acid	163.5	135.9	>97	1
Isovaleric acid	176.5	No	..	1
Acetamide	221.2	135.6	92	1

p-XYLENE (138.3°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Formic acid	100.7	95.0	30	1
Formic acid	100.7	100.5	1	1
n-Butyl alcohol	117.8	115.7	32	1
Acetic acid	118.5	115.1	33	1
Paraldehyde	124.1	No	..	1
Isoamyl alcohol	130.5	126.8	49	1
Dibromoethylene	131.5	131.3	..	1

(Continued)

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.

You wouldn't put a diving suit on a *POLE VAULTER*

LAY·SET *Preformed* IS LIMBER

● Putting non-preformed wire rope on your machines is like expecting a pole vaulter to make a record when dressed in a diving suit. You shouldn't expect a wire rope that is twisted tightly and under constant tension to operate well and long.

In Hazard LAY-SET Preformed every wire and strand is pre-shaped at the mill to the exact helix it must assume in the finished rope. That's why **LAY-SET** is at ease, relaxed, more flexible, and perfectly willing to work. Being free of torsional stresses and strains, being unhampered by twisted effort, Hazard **LAY-SET** Preformed lasts longer, gives you greater dollar value. Be sure your next rope is Hazard **LAY-SET** Preformed.

Hazard **LAY-SET** Preformed Wire Rope is "in the service" on countless jobs for the Armed Forces where it is proving its many advantages. Specify it for *your* use.

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HAZARD LAY·SET *Preformed* ROTARY LINES

HYDROCARBON AZEOTROPES

AROMATICS—Continued

p-XYLENE—Continued (138.3°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Propyl isobutyrate	134.0	No	..	1
Isobutyl propionate	136.9	136.8	15	1
Propionic acid	140.7	132.0	64	1
1, 2-Dibromopropane	141.7	137.5	88	1
Isoamyl acetate	142.1	No	..	1
Chloroethyl acetate	143.5	137.0	72	1
Isobutyric acid	154.4	133.5	80	1
Cyclohexanol	160.6	No	..	1
Furfural	161.5	138.0	95	1
n-Butyric acid	163.5	137.5	95	1
Isovaleric acid	176.5	No	..	1
Acetamide	221.2	137.5	91	1

m-XYLENE (139.0°C.)

Formic acid	100.7	94.2	29.8	1
Formic acid	100.7	No	..	1
Isobutyl alcohol	107.9	107.7	13	1
Isobutyl alcohol	107.9	No	..	4
n-Butyl alcohol	117.8	116.0	20	1
Acetic acid	118.5	115.4	27.5	1
Paraldehyde	124.1	No	..	1
Butyl acetate	125.8	No	..	1
Ethyl carbonate	126.0	No	..	1
Isoamyl alcohol	130.5	127.0	47	1
Ethylene bromide	131.5	No	..	1
Propyl isobutyrate	134.0	No	..	1
Ethyl isovalerate	134.7	No	..	1
Isobutyl propionate	136.9	134.5	..	1
Isobutyl propionate	136.9	No	..	2
Isoamyl acetate	138.8	136.0	50	3
Allyl sulphide	139.0	137.0	..	1
Propionic acid	140.7	132.7	64.5	1
1, 2-Dibromopropane	141.7	138.0	70	1
Isoamyl acetate	142.1	No	..	1
Butyl ether	142.2	No	..	1
Chloroethyl acetate	143.5	137.3	68	1
Propyl butyrate	143.5	138.7	..	1
Propyl butyrate	143.5	No	..	1
Paraldehyde	144.8	134.0	70	1
Isoamyl nitrate	149.5	No	..	1
Isobutyric acid	154.4	134.0	79	1
Isobutyric acid	154.4	136.8	86	1
Cyclohexanol	160.7	138.9	94.9	3
Furfural	161.5	138.4	88	1
n-Butyric acid	163.5	138.1	94.5	3
Methylacetoacetate	169.5	No	..	1
Dichlorohydrin	174.5	No	..	1
Isovaleric acid	176.5	No	..	1
Phenol	182.2	No	..	1
Aniline	184.4	No	..	1
Propionamide	213.0	138.5	..	1
Acetamide	221.2	138.2	86	1

o-XYLENE (143.6°C.)

Formic acid	100.7	95.5	26	1
Formic acid	100.7	100.5	1	1
n-Butyl alcohol	117.8	116.8	25	1
Acetic acid	118.5	116.0	24	1
Morpholine	128.0	No	..	17

o-XYLENE—Continued (143.6°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Isoamyl alcohol	130.5	128.0	40.4	3
Isobutyl propionate	136.9	No	..	1
Propionic acid	140.9	135.0	58	1
1, 2-Dibromopropane	141.7	139.2	30	1
Isoamyl acetate	142.1	No	..	1
Butyl ether	142.2	142.0	..	1
Propyl butyrate	143.5	143.2	45	1
n-Dipropyl ketone	143.6	143.0	58	1
Butyl propionate	146.5	No	..	1
Amyl acetate	149.0	No	..	1
Anisol	153.9	No	..	1
Cyclohexanone	155.7	No	..	1
Furfural	161.5	140.5	87	1
n-Butyric acid	162.5	142.0	90	1
Phenol	182.2	No	..	1

STYRENE (146°C.)

Methyl alcohol	64.8	64.2	..	2
n-Propyl alcohol	97.2	97.0	8	2
Water	100.0	Min.	..	21
n-Butyl alcohol	117.8	116.5	21	2
Acetic acid	118.5	116.0	17	2
Isoamyl alcohol	130.5	128.5	34.7	3
Propyl isobutyrate	134.0	No	..	1
Chloroethyl acetate	143.5	140.2	40	1
Propyl butyrate	143.5	No	..	1
Methyl lactate	143.8	134.5	50	1
sym-Tetrachloroethane	146.3	143.5	45	1
Butyl propionate	146.5	145.5	..	1
Ethyl lactate	154.0	140.5	75	1
Furfural	161.5	141.0	85	2
Methyl oxalate	163.3	<142.5	88	2
Methyl acetoacetate	169.5	143.0	73	1
Dichlorohydrin	175.1	143.5	85	2
Ethyl acetoacetate	180.0	145.2	96.3	3
Phenol	181.5	No	..	1
Acetamide	221.2	144.0	88	2

CUMENE (152.4°C.) (Isopropylbenzene)

Acetic acid	117.8	116.8	..	8

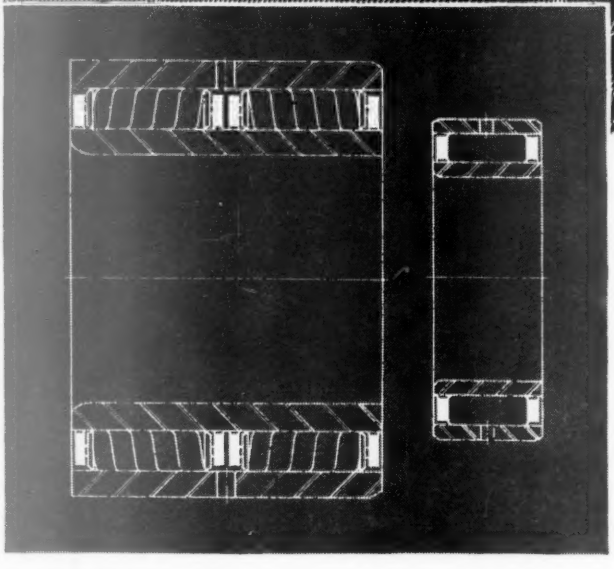
n-PROPYLBENZENE (158.9°C.)

Acetic acid	118.5	No	..	1
Isobutyl carbinol	131.3	130.6	17	2
Isoamyl nitrate	149.5	No	..	1
Ethyl lactate	154.0	147.0	42	1
Propyl isovalerate	155.5	No	..	1
Chloroacetal	157.4	<156.0	>25	1
Furfural	161.5	152.0	60	1
Methyl oxalate	164.2	152.5	58	1
Ethyl caproate	167.8	No	..	1
Methyl n-hexyl ketone	172.9	No	..	1
Methyl malonate	181.5	<159.0	..	1
Phenol	182.2	158.0	96	1
Monochloroacetic acid	189.5	156.0	..	2

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.

The Equipment that made 2 world records producing steel

BEARINGS: HYATT



Hyatt wound roller type as used in the table rollers. Hyatt 70,000 series solid roller type as used on line shafts. There's a size and type of Hyatt Roller Bearing for every application.

To a blooming mill that had established a world's record producing 171,440 tons of steel ingots in a month, was added more glory when 512 ingots were rolled by one of the three crews during an 8 hour turn.

Production like that would permit no time out for bearing wear or care, but this mill knew from past experience that with Hyatt Roller Bearings on all table rollers and line shafts all would be well, all the time.

In the petroleum field also, new production records are being made by machinery equipped with Hyatt Roller Bearings. Where the going is tough and performance counts it will pay to consider Hyatts.

HYATT BEARINGS DIVISION · GENERAL MOTORS CORPORATION

Harrison, New Jersey · Chicago · Detroit · Pittsburgh · Oakland, California

HYDROCARBON AZEOTROPES

AROMATICS—Continued

MESITYLENE
(164.6°C.)
(1, 3, 5-Trimethylbenzene)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Isoamyl alcohol	131.8	No	..	1
Propionic acid	140.7	139.3	23	1
Methyl lactate	143.8	142.0	<15	1
Isobutyric acid	154.4	148.5	48	1
Propyl isovalerate	155.5	No	..	1
Bromobenzene	156.1	No	..	1
Isobutyl butyrate	156.8	No	..	1
Isoamyl propionate	160.3	No	..	1
Cyclohexanol	160.7	156.3	44.8	3
p-Chlorotoluene	161.3	160.5	28	1
Furfural	161.5	155.2	40	1
Pentacholoroethane	162.0	166.0(max.)	60	2
Methyl oxalate	163.3	154.8	49.8	1
n-Butyric acid	163.5	158.5	33	3
Butyl butyrate	166.4	No	..	1
Isobutyl isovalerate	168.7	163.0	..	1
Methyl acetoacetate	169.5	160.5	57	1
Isobutyl isovalerate	171.4	No	..	1
Phenetol	171.5	No	..	1
Propyl lactate	171.7	160.0	75	1
Isoamyl ether	173.4	No	..	1
Isovaleric acid	176.5	162.8	81	1
Ethyl acetoacetate	180.4	162.5	68	1
Methyl malonate	181.5	162.0	<90	1
Phenol	182.2	No	..	1
Aniline	184.4	Min.	..	14
Aniline	184.4	No	..	1
Ethyl oxalate	185.7	No	..	1
Monochloroacetic acid	189.4	162.0	83	2
o-Cresol	191.9	No	..	1
Methyl succinate	195.5	No	..	1
Glycol	197.4	155.0	88	2
Acetamide	221.2	160.0	85	1

PSEUDOCUMENE
(168.2°C.)
(1, 2, 4-Trimethylbenzene)

Isoamyl alcohol	131.8	No	..	1
Propionic acid	140.7	140.0	90	2
Propionic acid	140.9	No	..	1
Isobutyric acid	154.4	149.4	42	1
Isobutyric acid	154.4	152.3	37	1
Cyclohexanol	160.6	158.0	40	1
Furfural	161.5	156.0	40	1
n-Butyric acid	162.5	159.0	50	1
Methyl oxalate	163.3	157.0	35	2
Ethyl caproate	167.8	167.6	..	1
Isobutyl isovalerate	168.7	166.5	49	1
Phenylethyl ether	170.5	168.1	>90	1
Isobutyl isovalerate	171.4	No	..	1
Phenetol	171.5	168.9	..	1
Isovaleric acid	176.5	163.8	77	1
Benzyl chloride	179.4	No	..	1
Ethyl acetoacetate	180.4	166.5	63	1
Methyl malonate	181.5	<165.5	<80	1
Phenol	181.5	167.0	74	1
Aniline	184.4	167.5	>85	2
Ethyl oxalate	185.7	167.9	94	2
Caproic acid	205.2	No	..	1

CYMENE
(176.7°C.)
(Methyl isopropyl benzene)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Isoamyl alcohol	131.8	No	..	1
Propionic acid	140.7	No	..	1
Cyclohexanol	160.6	159.0	29	1
Furfural	161.5	157.8	32	2
Methyl oxalate	163.3	161.0	20	1
n-Butyric acid	163.5	160.5	43	1
Phenetol	170.5	No	..	1
Isobutyl isovalerate	171.4	No	..	1
Dichlorohydrin	174.5	165.0	52	1
o-Chlorophenol	175.5	173.5	50	1
Eucalyptol	176.4	176.0	..	2
Isovaleric acid	176.5	168.0	63	1
p-Cresol methyl ether	177.1	No	..	1
Isoamyl butyrate	178.6	<173.0	..	1
sec-Octyl alcohol	178.7	172.5	..	1
Benzaldehyde	179.2	171.0	72	1
Ethyl acetoacetate	180.4	170.5	..	1
Ethyl acetoacetate	180.7	172.0	>55	1
Methyl malonate	181.5	169.0	60	1
Phenol	181.5	170.0	66	1
Isobutyl lactate	182.2	171.5	65	1
Aniline	184.4	170.0	70	2
Ethyl oxalate	185.7	174.0	85	1
Chloroacetic acid	186.5	166.0	65	1
o-Cresol	190.8	175.0	..	1
Phenyl acetate	195.7	No	..	1
Caproic acid	205.2	No	..	1
Acetamide	221.2	170.5	81	2

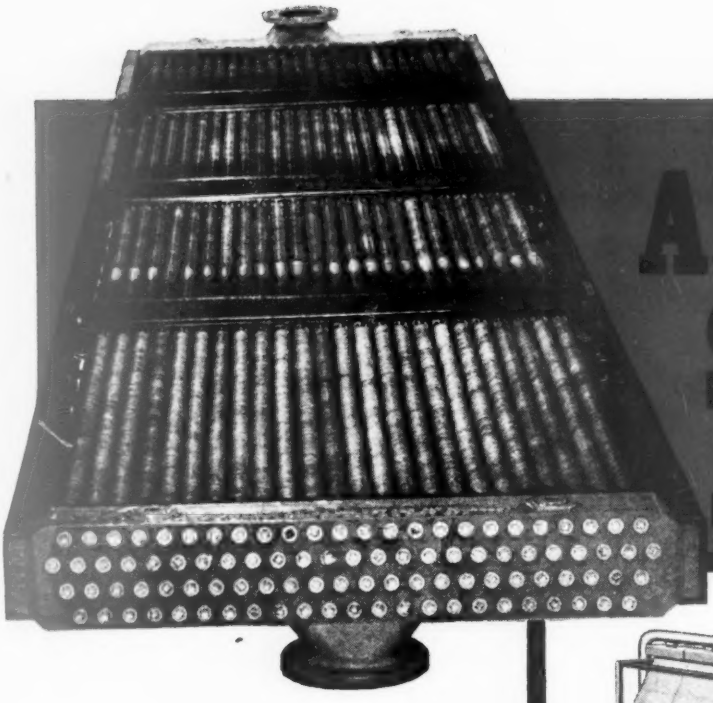
INDENE
(182.4°C.)

Formic acid	108.0	No	..	1
Isobutyric acid	154.4	No	..	1
Cyclohexanol	160.7	160.0	25	2
n-Butyric acid	162.5	161.0	..	2
Isobutyl isovalerate	171.4	No	..	1
Monoethanolamine	172.0	Min.	..	25
o-Chlorophenol	174.0	Min.	..	25
Isovaleric acid	176.5	173.5	45	1
Isoamyl butyrate	178.5	178.0	..	1
Isobutyl lactate	182.2	177.0	48	1
Phenol	182.2	177.8	47	1
Aniline	184.4	176.8	55	2
Propylene glycol	187.4	Min.	..	25
o-Cresol	191.1	182.3	91	1
Isoamyl isovalerate	192.7	No	..	1
Diethylene glycol monomethyl ether	193.2	Min.	..	25
Ethylene glycol	197.0	Min.	..	25
Phorone	197.8	No	..	1
p-Cresol	201.7	No	..	1
m-Cresol	202.2	No	..	1
Acetamide	221.2	177.6	82.5	2

n-BUTYLBENZENE
(183.2°C.)

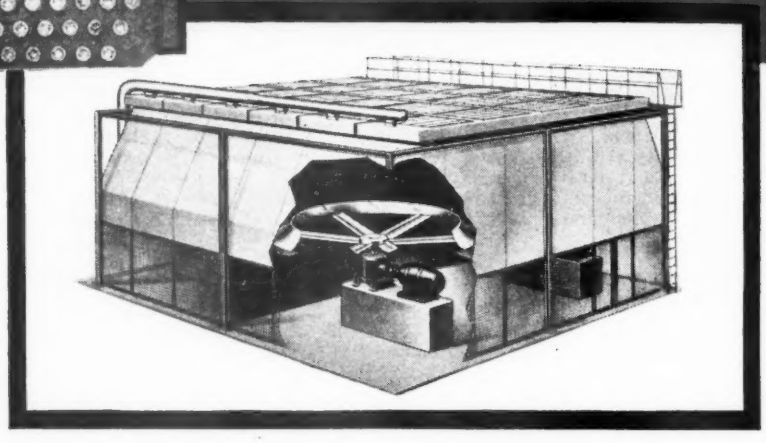
Furfural	161.5	160.5	18	1
Methyl n-Hexyl ketone	172.9	No	..	1
Eucalyptol	176.4	No	..	1
p-Cresol methyl ether	177.1	No	..	1

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.



K-FIN AIR-COOLED SECTIONS

are incorporated in the FIN-FAN HEAT EXCHANGER



Portion of K-Fin tubing. This finned tubing has also proven its effectiveness and durability in shell-and-tube type vapor condensers involving cooling of non-condensibles, gas-to-liquid heat exchangers including steam generating elements, and reboilers.

In the Fin-Fan Heat Exchanger, a joint development of The Fluor Corp., Ltd. and The Griscom-Russell Co., fluid cooling and condensing services are accomplished by G-R K-FIN SECTIONS utilizing Fan-circulated atmospheric air as the coolant. This represents the most recent application of G-R K-FIN ELEMENTS, the patented Helically-Finned Tube developed over fifteen years ago, and used in many thousands of units for heating and cooling air and other gases.

Note the provision in the headers for accessibility to the tube interiors plus the fully demountable supports employed, both distinctive features permitting internal cleaning and replacement of individual elements.

Write for complete information on these standard, interchangeable condensing and cooling sections, and on the Fin-Fan Heat Exchanger.

THE GRISCOM-RUSSELL CO.

285 Madison Avenue New York 17, N. Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

HYDROCARBON AZEOTROPES

AROMATICS—Continued

sym-TRIETHYLBENZENE (216°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Ethyl acetoacetate	180.7	No	..	1
Phenol	181.5	No	..	1
Aniline	184.4	No	..	1
o-Cresol	191.1	No	..	1
Methyl succinate	195.5	No	..	1
Phenyl acetate	195.7	No	..	1
p-Cresol	201.8	201.5	4	1
m-Cresol	202.2	No	..	1
Benzyl formate	202.3	No	..	1
Benzyl alcohol	205.5	200.2	45	1
Nitrobenzene	210.8	No	..	1
Borneol	211.8	211.0	45	1
Propyl oxalate	212.0	210.0	30	1
Ethyl benzoate	212.6	No	..	1
Benzyl acetate	215.5	214.5	50	1
p-Chlorophenol	217.0	214.7	82	1
o-Nitrophenol	217.3	214.3	55	1
Acetamide	221.2	198.0	73	2
Bornyl acetate	227.7	No	..	1
Thymol	232.9	No	..	1
n-Caproic acid	237.5	214.3	96	2
Pyrocatechol	245.9	214.7	..	1
Pyrocatechol	245.9	214.7	..	2
Resorcinol	281.4	No	..	1

NAPHTHALENE (218.1°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Ethanol	78.3	No	..	1
n-Butyric acid	163.5	No	..	1
Isovaleric acid	176.5	No	..	1
Phenol	181.5	No	..	1
β-Chlorohydrin	183.0	No	..	1
Aniline	184.4	No	..	1
Chloroacetic acid	186.5	184.0	15	1
o-Cresol	190.8	No	..	1
Methyl succinate	195.5	No	..	1
Phenyl acetate	195.7	No	..	1
Trichloroacetic acid	196.0	190.0	..	1
Methyl aniline	196.1	No	..	1
Glycol	197.4	183.9	49	24
Ethyl malonate	198.9	No	..	1
o-Toluidine	200.7	No	..	1
p-Cresol	201.8	No	..	1
Benzyl formate	202.3	No	..	1
Caproic acid	205.2	202.0	30	1
Benzylidene chloride	205.2	No	..	1
Benzyl alcohol	205.5	204.3	40	1
Ethyl aniline	206.0	205.0	10	1
Camphor	208.9	No	..	1
Nitrobenzene	210.8	No	..	1
Borneol	211.8	211.3	15	1
Propyl oxalate	212.0	No	..	1
Ethyl benzoate	213.0	No	..	1
Benzyl acetate	215.5	215.3	28	1
Methyl Ester of terpineol	216.0	No	..	1
Diethyl aniline (N)	216.5	213.0	..	1
Ethyl succinate	216.5	210.0	43	1
p-Chlorophenol	217.0	215.9	36.5	1
Tribromohydrin	220.0	216.5	..	1
Acetamide	221.2	199.5	72.8	2
Propionamide	222.1	204.7	68.5	2
o-Nitrotoluene	222.3	No	..	1

NAPHTHALENE—Continued (218.1°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Citral	226.0	No	..	1
Bornyl acetate	227.7	No	..	1
Ethyl phenyl acetate	228.8	No	..	1
Geraniol	229.5	No	..	1
Propyl benzoate	231.2	No	..	1
Isoamyl carbonate	232.2	No	..	1
Thymol	232.9	No	..	1
Safrol	235.9	No	..	1
Caprylic acid	237.5	216.2	94	1
Pyrocatechol	245.9	217.5	88.5	1
Benzoic acid	249.0	No	..	1
Benzoic acid	250.5	217.7	95	2
Propyl succinate	250.5	No	..	1
Phenylacetic acid	266.5	No	..	1
Resorcinol	281.4	No	..	1
Glycerol	291.0	215.2	90	24

α-METHYLNAPHTHALINE (245.1°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Ethyl succinate	217.3	No	..	1
Acetamide	221.2	209.8	56.2	2
Propionamide	222.1	215.0	48	2
Bornyl acetate	227.7	No	..	1
Ethyl phenyl acetate	228.8	No	..	1
Isoamyl carbonate	232.2	No	..	1
o-Phenetidine	232.5	No	..	1
Thymol	232.9	No	..	1
Caprylic acid	237.5	233.5	48	1
Isobutyl benzoate	241.9	No	..	1
Pyrocatechol	245.9	234.8	60	1
Butyl benzoate	249.5	No	..	1
Propyl succinate	250.5	No	..	1
Benzoic acid	250.5	239.6	73	1
Eugenol methyl ether	254.7	No	..	1
Methyl cinnamate	261.9	No	..	1
Phenylacetic acid	266.5	243.2	88	2
Resorcinol	281.5	243.1	85.5	2
α-Naphthol	288.0	No	..	1

DIPHENYL (255.9°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Glycol	197.4	192.0	36	24
Acetamide	221.2	213.0	49.5	2
Thymol	232.9	No	..	1
Pyrocatechol	245.9	239.9	45	1
Butyl benzoate	249.5	No	..	1
p-Phenetidine	249.9	249.0	30	1
Benzoic acid	250.7	246.1	50	2
β-Isosafrol	252.0	No	..	1
Phenyl acrolein	253.5	250.0	60	1
Eugenol methyl ether	254.7	254.5	..	1
Eugenol	254.8	243.2	50	1
Methyl cinnamate	261.9	No	..	1
Isoamyl benzoate	262.0	No	..	1
Phenylacetic acid	266.5	252.2	76.7	24
Isoamyl oxalate	268.0	No	..	1
Resorcinol	281.4	252.2	79	2
Methyl phthalate	283.7	No	..	1
α-Naphthol	288.0	No	..	1
β-Naphthol	290.0	No	..	1
Glycerol	291.0	243.8	45	24

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.

This Simple Compressor Meets the Complex Needs of a Changing Petroleum Industry

It's the Nash!

Here is a compressor presenting advantages found in no other device. Nash Compressors have only one moving part, rotating without metallic contact with the pump casing. No internal lubrication is required. Yet they produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure.

There are no valves, gears, pistons, sliding vanes, or other complicated wearing parts in a Nash. Compression is secured by an entirely different principle of operation. Because of this, gas pumping problems difficult with ordinary pumps are often easily handled by the Nash. For example, Nash Pumps are standard equipment in the Synthetic Rubber Industry, where they have met the needs of new and difficult processes.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. They maintain original performance over long periods. Service is assured by a nationwide net-work of Engineering Service offices. Instructive bulletin shows how they operate. Write for it.

One moving part.

No internal wearing parts.

No valves, pistons, or sliding vanes.

No internal lubrication.

Low maintenance.

Slugs of liquid entering pump do no harm.

Non-pulsating pressure.

Saves floor space.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

272 WILSON, SO. NORWALK, CONN.

HYDROCARBON AZEOTROPES

AROMATICS—Continued

DIPHENYL METHANE (265.6°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Acetamide	221.2	215.5	43.5	2
Propionamide	222.1	219.2	40	2
Pyrocatechol	245.9	242.8	35	1
p-Phenetidine	249.9	No	..	1
Benzoic acid	250.5	249.0	17	1
Phenyl acrolein	253.5	No	..	1
Methyl cinnamate	261.9	No	..	1
Isoamyl benzoate	262.0	No	..	1
Phenylacetic acid	266.5	258.7	65	1
Isoamyl oxalate	268.0	265.2	85	1
Ethyl cinnamate	272.5	No	..	1
Resorcinol	281.4	259.0	74	1
Methyl phthalate	283.7	No	..	1
α-Naphthol	288.0	265.0	90	1
β-Naphthol	290.0	No	..	1

ACENAPHTHENE (277.9°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Acetamide	221.2	217.0	35.8	2
Pyrocatechol	245.9	245.3	16	2
Benzoic acid	250.5	250.0	..	2
Methyl cinnamate	261.9	No	..	1

ACENAPHTHENE—Continued (277.9°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Isoamyl benzoate	262.0	No	..	1
Phenylacetic acid	266.5	262.6	29	1
Isoamyl oxalate	268.0	No	..	1
Isoeugenol methyl ether	270.5	No	..	1
Ethyl Cinnamate	272.5	No	..	1
Resorcinol	281.4	266.2	59	2
Methyl phthalate	283.7	276.4	66.5	1
α-Naphthol	288.0	274.0	80	1
Glycerol	290.0	259.1	71	2
β-Naphthol	290.0	277.0	90	1

DIBENZYL (284°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Acetamide	221.2	218.2	32	2
Pyrocatechol	245.9	No	..	1
Benzoic acid	250.5	No	..	1
Phenylacetic acid	266.5	264.3	10	1
Isoamyl oxalate	268.0	No	..	1
Ethyl cinnamate	272.5	No	..	1
Resorcinol	281.9	269.7	53	2
Methyl phthalate	283.7	280.5	47	1
β-Naphthol	290.0	283.5	..	1

BINARY AZEOTROPES WHERE BOTH COMPONENTS ARE HYDROCARBONS

PARAFFIN-PARAFFIN

Name of Hydrocarbon No. 1	Boiling point of Hydrocarbon No. 1, °C. 760 mm.	Name of Hydrocarbon No. 2	Boiling point of Hydrocarbon No. 2, °C. 760 mm.	Azeotropic temperature, °C. 760 mm.	Azeotropic composition, wt. % H.C. No. 1	Reference number
Ethane	-88.3	n-Butane	0.6	No	..	1
Isopentane	28.0	n-Pentane	36.2	No	..	1
n-Hexane	69.0	n-Octane	125.8	No	..	4

PARAFFIN-OLEFIN

Ethane	-88.3	Acetylene	-88.5	Min.	..	1
Isopentane	28.0	3-Methylbutene-1	22.5	20.0	..	1
Isopentane	28.0	Isoprene	34.1	27.0	..	1
Isopentane	28.0	2-Methylbutene-2	37.2	?	..	1
n-Pentane	36.2	Isoprene	34.1	33.8	10	1
n-Pentane	36.2	2-Methylbutene-2	37.2	35.5	57	1

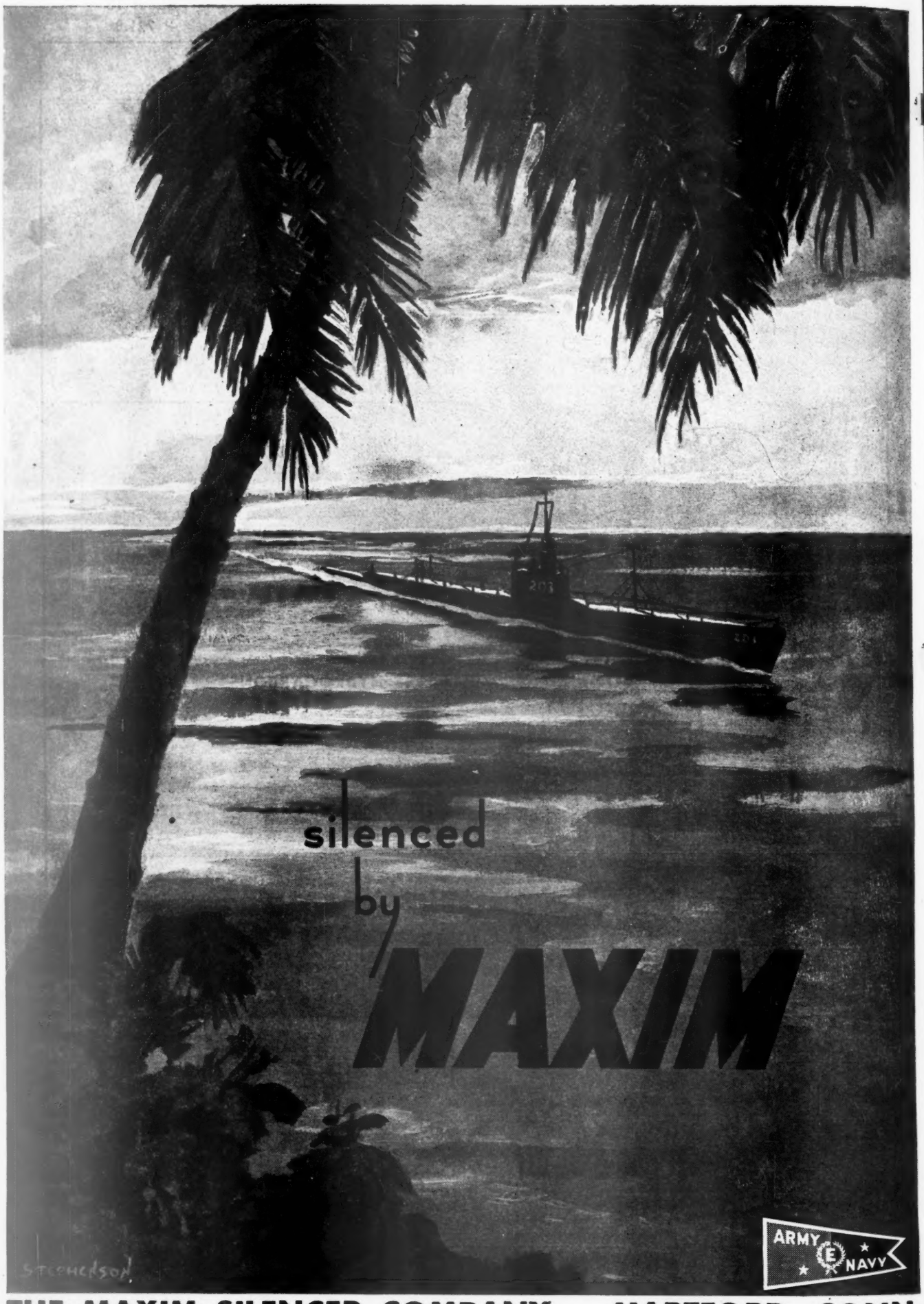
PARAFFIN-NAPHTHENE

n-Hexane	69.0	Cyclohexane	80.8	No	..	1
n-Hexane	69.0	Methylcyclopentane	71.8	Min.	..	18
n-Heptane	98.5	Methylcyclohexane	101.8	No	..	19

PARAFFIN-AROMATIC

n-Hexane	69.0	Benzene	80.2	68.9	19	1
n-Hexane	69.0	Benzene	80.2	No	..	1
n-Octane	125.8	Ethylbenzene	136.2	No	..	1

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.



THE MAXIM SILENCER COMPANY . . HARTFORD, CONN.

HYDROCARBON AZEOTROPES

BINARY AZEOTROPES WHERE BOTH COMPONENTS ARE HYDROCARBONS—Continued

PARAFFIN-CYCLIC OLEFIN

Name of Hydrocarbon No. 1	Boiling point of Hydrocarbon No. 1, °C. 760 mm.	Name of Hydrocarbon No. 2	Boiling point of Hydrocarbon No. 2, °C. 760 mm.	Azeotropic temperature, °C. 760 mm.	Azeotropic composition, wt. % H.C. No. 1	Reference number
n-Hexane	69.0	Cyclohexene	82.8	No	..	1
2, 7-Dimethyloctane	160.3	Camphene	158.0	157.0	..	1

NAPHTHENE-AROMATIC

Methylcyclopentane	71.8	Benzene	80.2	71.4	90.6	20
Cyclohexane	80.8	Benzene	80.2	77.5	45	1
Cyclohexane	80.8	Toluene	110.7	No	..	1

NAPHTHENE-CYCLIC OLEFIN

Cyclohexane	80.8	1, 3-Cyclohexadiene	80.8	79.2	52	1
Cyclohexane	80.8	Cyclohexene	82.8	No	..	1

OLEFIN-OLEFIN

Ethylene	−103.9	Acetylene	−88.5	Min.	..	23
Isoprene	34.1	2-Methylbutene-2	37.2	No	..	1
2-Methylbutene-2	37.2	3-Methyl-1, 2-Butadiene	40.8	No	..	1

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.

BIBLIOGRAPHY

1. Allen, C., Use of Azeotropic Data for Calculating General Properties of Binary Systems, Ind. Eng. Chem. *22*, 608-9 (1930).
2. Batuev, M. I. and Landsberg, G. S., The Hydrogen Bond (Review of Subject) Uspeckhi, Khim. *10*, 416-55 (1941).
3. Brame, J. S. S. and Hunter, T. G., Hydrocarbon Separation, J. Inst. Pet. Tech. *13*, 794-816 (1927).
4. Bratton, A. C., Felsing, W. A., and Bailey, J. R., Amplified Distillation, Ind. Eng. Chem. *28*, 424-30 (1936).
5. Britton, E. C., Nutting, H. S., and Horsley, L. H., Separation of Butene-l and Isobutylene, U. S. Patent 2,207,608 (1940).
6. Bruun, J. H. and Ricks-Bruun, M. M., The Isolation of the Isomers of Hexane from Petroleum, Bur. Std. Jour. Res. *5*, 933-42 (1930) RP 239.
7. Callingaert, G. and Hitchcock, L. B., The Application of The Phase Rule to The Calculation of Liquid and Vapor Compositions in Binary Systems. Deviations from Raoult's Law for Hydrocarbon Mixtures, J.A.C.S. *49*, 750-65 (1927).
8. Carlson, H. C. and Colburn, A. P., Vapor-Liquid Equilibrium of Non-Ideal Solutions, Ind. Eng. Chem. *34*, 581-9 (1942).
9. Craven, E. C., Third Component Method in Fractional Distillation, Ind. Chem. Vol. 9, No. 106, 414-7 (1933).
10. Deanesley, R. M., Olefin-Paraffin Separation, U. S. Patent 1,866,800 (1932).
11. Ibid., Distillation Process, U. S. Patent 2,290,636 (1942).
12. Dunn, C. L. and McConaughy, R. B., Recovery of Pure Aromatics, U. S. Patent 2,288,126 (1942).
13. Ebersole, M. R., Minimum Boiling Points and Vapor Compositions, J. Phys. Chem. *5*, 239-55 (1901).
14. Emeleus, H. J., The Hydrogen Bond, Chem. & Ind. *18*, 583-5 (1940).
15. Errera, J., Relation Between Vapor Pressure of Binary Liquid Mixtures and Polarity of Molecular Constituents, Compt. Rend. *187*, 727-30 (1928).
16. Ewell, R. H. and Welsh, L. M., Maximum Boiling Mixtures and Donor Liquids, J.A.C.S. *63*, 2475-8 (1941).
17. Faraday Society, General Discussion on Dipole Moments, Trans. Faraday Soc. *30*, 677-904 (1934).
18. Ibid., General Discussion on Structure and Molecular Forces in (a) Pure Liquids and (b) Solutions, Trans. Faraday Soc. *33*, Pt. I, 1-282 (1937).
19. Ibid., General Discussion of the Hydrogen Bond, Trans. Faraday Soc. *36*, Pt. 2, 871-929 (1940).
20. Field, E., Azeotropic Distillation, U. S. Patent 2,279,194 (1942).
21. Ibid., Azeotropic Distillation, U. S. Patent 2,302,608 (1942).
22. Frey, F. E., Matuszak, M. P. and Snow, R. D., Paraffin-Olefin Separation, U. S. Patent 2,186,524 (1940).
23. Geckler, R. D. and Fragen, N., Method of Producing Toluene, U. S. Patent 2,316,126 (1943).
24. Getman, F. H. and Daniels, F., Outlines of Theoretical Chemistry, John Wiley & Sons, N. Y. (1937).
25. Golodetz, A., Azeotropic Separations, U. S. Patent 1,079,004 (1913).
26. Greenburg, R. B., Distillation of Benzene Fractions, U. S. Patent 2,313,536 (1943).
27. Ibid., Recovery of Xylenes, U. S. Patent 2,313,537 (1943).
28. Ibid., Distillation of Benzene Fractions, U. S. Patent 2,313,538 (1943).
29. Guinot, H. M., Separation of Paraffin-Olefin Mixtures, U. S. Patent 2,316,860 (1943).
30. Guinot, H. M. and Clark, F. W., Azeotropic Distillation in Industry, Trans. Inst. Chem. Engrs., London, Adv. Copy (1938).
31. Herz, W. and Levi, M., Physical Chemical Measurements of Azeotropic Mixtures, Z. Anorg. Allgem. Chem. *183*, 340-6 (1929).
32. Hildebrand, J. H. and Carter, J. M., Ideal Solution Laws and Polarity Distribution, Proc. Nat. Acad. Sci. *16*, 285-8 (1930).
33. Hildebrand, J. H., Dipole Attraction and Hydrogen Bond Formation In Their Relation to Solubility, Science *83*, 21-4 (1936).
34. Ibid., Solubility (Monograph Series) 2nd Edition, Reinhold Publishing Corp. (1936).
35. Ibid., Intermolecular Forces In Solution, Trans. Faraday Soc. *33*, 144-51 (1937).
36. Ibid., Order and Disorder in Pure Liquids and Solutions, Science *90*, 1-8 (1939).
37. Huggins, M. L., Hydrogen Bridges in Organic Compounds, J. Org. Chem. VI, 407-56 (Mar.-Jan., 1936-7).
38. International Annual Table of Constants, Azeotropic Mixtures, Vol. XI, Pt. 1, Sec. 13, 51-5 (1931-4).
39. International Critical Tables, Constant Boiling (Azeotropic) Mixtures, Vol. III, 318-24.
40. Kamienski, B., Influence of the Boiling Temperature on the Composition of Azeotropic Mixtures, Roczniki Chem. *11*, 1-11 (1931).
41. Kelly, M. E., Separating Hydrocarbons from Petroleum by Azeotropic Distillation, Fuel *21*, 23-4 (1942).
42. Keyes, D. B., Binary Liquid Mixtures, Ind. Eng. Chem. 33, 1019-21 (1941).
43. Kireev, V. A., The Theory of Azeotropic Mixtures, Acta Physicochim (URSS) *14*, 371-86 (1941).
44. Kohnstamm, P. A. and Timmermans, J., On Vapor Pressures in Binary Systems with Partial Miscibility of The Liquids, Proc. Amst. *13*, 865-80, 957 (1910).

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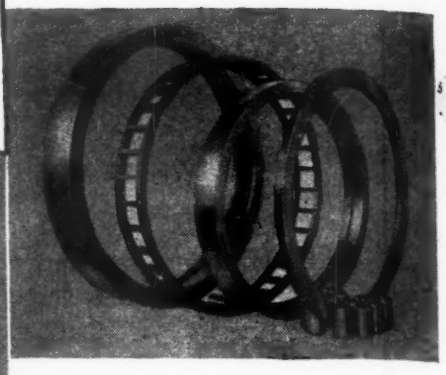
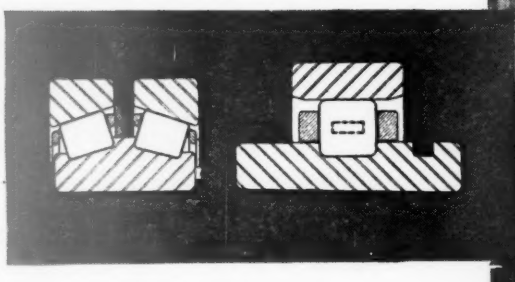
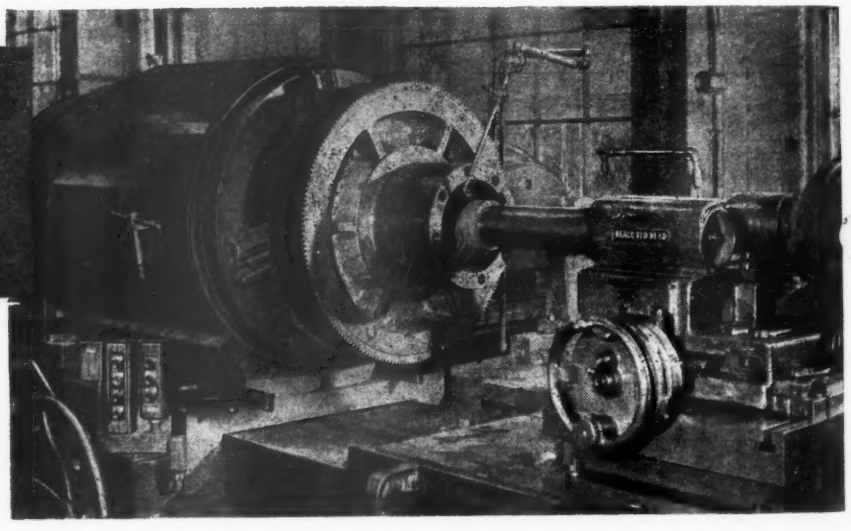
IN THE NEWS
WITH TORRINGTON BEARINGS

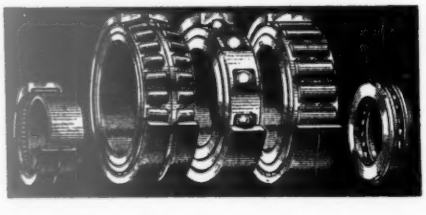


MEETING DESIGN REQUIREMENTS of the Emsco Derrick & Equipment Company, the engineers of Torrington's Bantam Bearings Division custom-built the 27½" O.D. Radial Roller Bearings employed in the sheaves of the crown and traveling blocks. The bearings, mounted on a center drum, are located close to the rope grooves to conserve wire line, prevent hazardous tilting, and to minimize wear on the sheaves.



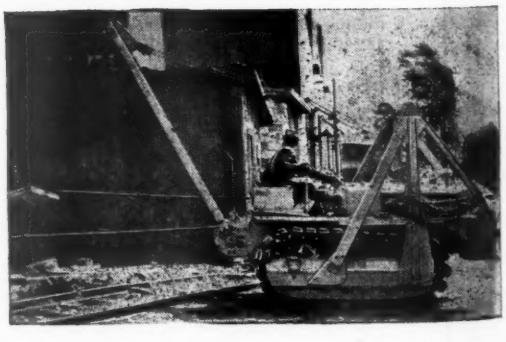


GRINDING HEAVY PARTS TO PRECISION LIMITS, this mammoth grinder, built by the Ingersoll Milling Machine Company, utilizes a Torrington Tapered Roller Bearing to carry the heavy radial and thrust loads encountered in the operation of the spindle. It is mounted directly behind the chucking mechanism which holds the work in position for grinding. A tapered bore radial roller bearing is mounted on the back end of the spindle, where a "V" belt pulley connects direct to the motor drive. After four years in operation the eccentricity and face run-out of these bearings is .00025.



EVERY MAJOR TYPE OF ANTI-FRICTION BEARINGS is included in the Torrington line—straight roller, tapered roller, needle and ball. In addition to supplying every branch of industry with a wide range of standard bearings, the engineering staff of Torrington's Bantam Bearings Division designs bearings in large sizes and of special types for new or unusual applications. For experienced counsel in meeting today's requirements—or assistance in postwar plans TURN TO TORRINGTON.

DESIGNERS of this Williamette Hyster towing winch, installed on a Caterpillar tractor, specified heavy-duty Torrington Needle Bearings for use in the idler and reverse gears. The Williamette Hyster Company says, "Because of the restricted space in the comparatively small gears, needle bearings are the only practical type of anti-friction bearings that can be used."



ARMY E NAVY

TORRINGTON BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

THE TORRINGTON COMPANY • BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

HYDROCARBON AZEOTROPES

BINARY AZETOTROPES WHERE BOTH COMPONENTS ARE HYDROCARBONS—Continued

OLEFIN-AROMATIC

Name of Hydrocarbon No. 1	Boiling point of Hydrocarbon No. 1, °C. 760 mm.	Name of Hydrocarbon No. 2	Boiling point of Hydrocarbon No. 2, °C. 760 mm.	Azeotropic temperature, °C. 760 mm.	Azeotropic composition, wt. % H.C. No. 1	Reference number
2-Methylbutene-2	37.2	Benzene	80.2	Min.	..	1

CYCLIC OLEFIN-CYCLIC OLEFIN

1, 3-Cyclohexadiene	80.8	Cyclohexene	82.8	No	..	1

CYCLIC OLEFIN-AROMATIC

1, 3-Cyclohexadiene	80.8	Benzene	80.2	No	..	1
Cyclohexene	82.8	Benzene	80.2	79.5	15	1
β-Pinene	163.8	Mesitylene	164.0	162.7	52	1
Menthene	170.8	Pseudocumene	169.0	168.0	20	1
Carvene	177.8	Cymene	175.3	174.4	25	1

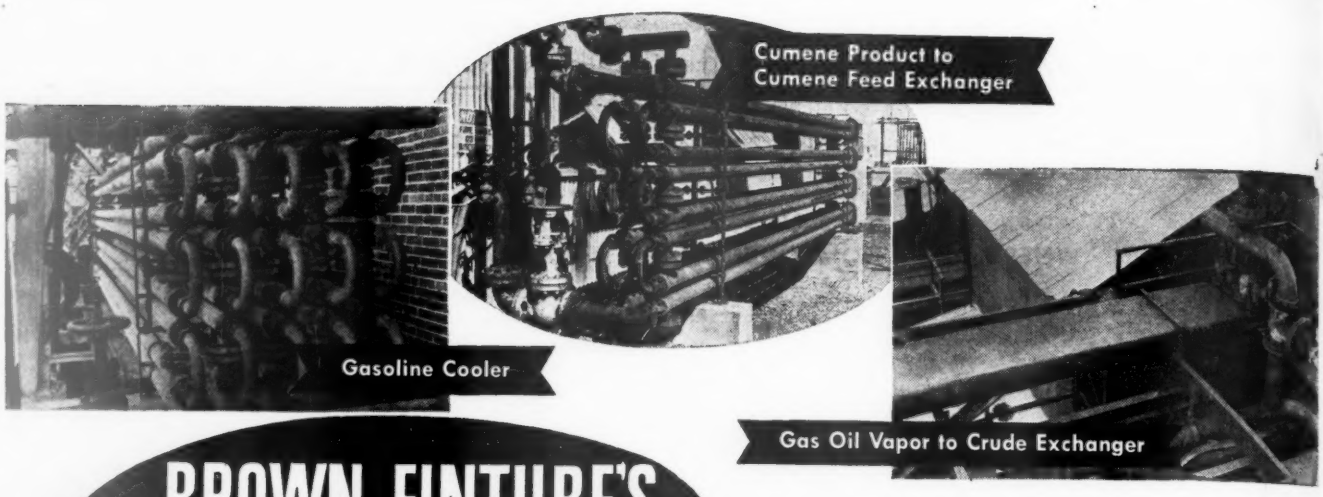
AROMATIC-AROMATIC

Benzene	80.2	Toluene	110.7	No	..	4
Benzene	80.2	Mesitylene	164.6	No	..	1
Toluene	110.7	Ethylbenzene	136.1	No	..	4
Ethylbenzene	136.2	p-Xylene	138.2	No	..	1
p-Xylene	138.2	m-Xylene	139.0	No	..	1
o-Xylene	142.6	Stryene	145.7	No	..	1
Mesitylene	164.0	Pseudocumene	169.0	No	..	1
Naphthalene	218.1	sym-Triethylbenzene	216.0	215.0	35	1

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.

BIBLIOGRAPHY—Continued

45. Kumler, W. D., The Effect of the Hydrogen Bond on the Dielectric Constants and Boiling Points of Organic Liquids., J.A.C.S. *57*, 600-5 (1935).
46. Lassettre, E. N., The Hydrogen Bond and Association, Chem. Rev. 20, 259-303 (1937).
47. Le Borgnet, E. and Schmitt, M., Variation of the Azeotropic Concentration with Pressure, Bull. Soc. Sci. Bretagne *13*, 72-5 (1936).
48. Lecat, M., La tension de vapeur des melanges de liquides. L'Azeotropisme. Bruxelles (1918).
49. Ibid., References to complete work given in Bibliographie de L'Azeotropisme, Bruxelles (1932).
50. Lee, R., Separation of Hydrocarbons, U. S. Patent 2,319,694 (1943).
51. Lemond, H., Diffusion and Azeotropism in Binary Mixtures, Compt. Rend. *202*, 1069-71 (1936).
52. Lewin, J., Recherches sure la theorie des solutions concentrees. La composition des phases liquides-vapeur au equilibre dans les systems binaires, Bull. Soc. Chim. Belg. *39* (1930).
53. Mair, B. J., Glasgow, A. R. Jr., and Rossini, F. D., Separation of Hydrocarbons by Azeotropic Distillation, Bur. Std. Jour. Res. *27*, 39-63 (1941) RP 1402.
54. Mariller, C., Azeotropic Mixtures, Chimie & Ind. *44*, 186-90 (1940).
55. Moelwyn-Hughes, E. A. and Sherman, A., Kinematic Consequences of Complex Formation in Solution, Chem. Soc. J. Pt. I, 101-10 (1936).
56. Mund, W., Some Conditions Which Are Necessary But Not Sufficient for the Appearance and Disappearance of Azeotropism in Binary Systems, Bull. Soc. Chim. Belg. 38, 322-8 (1929).
57. Othmar, D. F. and White, R. E., Treating Azeotropic Condensate, U. S. Patent 2,275,802 (1942).
58. Pauling, L., The Nature of the Chemical Bond, Cornell U. Press (1939).
59. Rabcewicz-Zubkowski, I., Azeotropy and Preparation of Pure Compounds, Roczniki Chem. *12*, 567-75 (1932).
60. Ibid., Study of Binary Azeotropic Mixtures and Classification, Roczniki Chem. 13, 16-19 (1933).
61. Ibid., Apparatus for Determining the Composition of Certain Azeotropic Mixtures, Roczniki Chem. *13*, 193-200 (1933).
62. Ibid., Changes in Composition of Azeotropic Binary Mixtures in Relation to Temperature Variation, Roczniki Chem. 13, 384-9 (1933).
63. Ibid., Differences and Similariites Between Azeotropic and Heteroazeotropic Phenomena and Relation Between Composition of Heteroazeotrope and Temperature, Roczniki Chem. *14*, 19-23 (1934).
64. Ramos, R. Z., Calculation of the Maximum Production Capacity Applied to Continuous Process Equipment for Ethyl Alcohol Manufacture, Rev. Quim (Mex.) *5*, 95-108 (1942).
65. Rennotte, J., Apparatus for Azeotropic Separation of Liquid Mixtures, Fr. Patent 823,387 (1938).
66. Robinson, C. S., Boiling Point Relations for Various Azeotropic Mixtures, Elements of Fractional Distillation, McGraw-Hill, Appendix Table III, 230-5 (1930).
67. Rossini, F. D., Mair, B. J., and Glasgow, A. R., Jr., Use of Azeotropic Distillation in Separating Hydrocarbons from Petroleum, Proc. Am. Pet. Inst. J. *21* III, 43-7 (1940).
68. Rossini, F. D., Hydrocarbons in Petroleum, Pet. Eng., Vol. 14, No. 5, 41-60 (Feb., 1943).
69. Schicktanz, S. T., Separation of Constant-Boiling Mixtures of Naphthene and Paraffin Hydrocarbons, Bur. Std. Jour. Res. *15*, 129-36 (1937) RP 967.
70. Schouls, G., Dynamic Azeotropism, Bull. Sci. Acad. Roy. Belg. *16*, 628-45, 1412-24 (1930); *17*, 47-59, 191-202, 369-78, 630-44 (1931); *18*, 1160-8 (1932).
71. Sklyarenko, S. I. and Baranaev, M. K., The Azeotropes and Constant-Boiling Mixtures, Z. Physik Chem., *A-175*, 203-13 (1935).
72. Spiers, H. M. and Suttle, H. K., Purifying Aromatic Hydrocarbons by Azeotropic Distillation, Brit. Patent 536,172 (1941).
73. Sullivan, F. W., Process for Recovering Toluene, U. S. Patent 2,265,220 (1941).
74. Sunier, A. A. and Rosenblum, C., Physical Methods of Separating Constant Boiling Mixture, J. Ind. Eng. Chem., Anal. Ed. 2, 109-13 (1930).
75. Sutherland, H. K., Azeotropic Distillation, U. S. Patents 2,290,654 and 2,302,608 (1942).
76. Swietoslawski, W., Ebulliometry, Chem. Pub. Co. Inc., N. Y. (1937).
77. Ibid., Principle Phenomena In Azeotropic Mixtures Composed of Several Components, Roczniki Chem. *10*, 97-112 (1930).
78. Ibid., See Item No. 49.
79. Timmermans, J., Les Solutions Concentrees, Mason & Cie, Paris (1936).
80. Ibid., See item No. 49.
81. Washburn, E. W., Separating by Distillation at Other than Normal Pressure, J. Ind. Eng. Chem. *25*, 891-4 (1933).
82. White, J. D. and Rose, F. W., Jr., Hydrocarbon Separation, Bur. Std. Jour. Res. *17*, 943-954 (1936) RP 955; *21*, 151-165 (1938) RP 1122; *21*, 167-184 (1938) RP 1123.
83. Wright, R., Fractional Distillation of Mixtures of Constant-Boiling Point, J. Chem. Soc., Pt. 2, 1720-1 (1938).
84. Zhdanov, A. K., Increase in Entropy During Formation of Azeotropic Mixtures, J. Gen. Chem. (USSR) *11*, 483-92 (1941).



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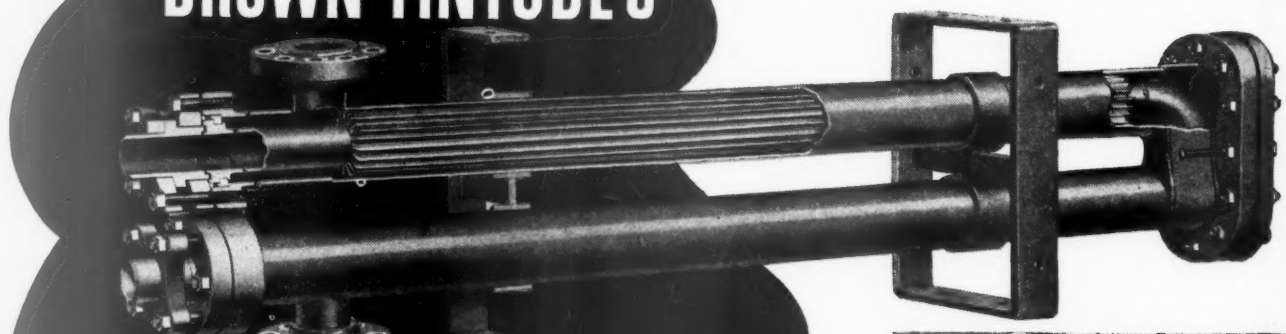

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MANUFACTURERS OF INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT EXCHANGERS

Running Tour WITH MEN IN THE INDUSTRY

▸ **John W. de Groot,** vice president of Tuscarora Oil Company, Ltd., has been appointed president to succeed **John P. Fallon,** retired. **A. F. Aylsworth** succeeds de Groot as vice president and will retain his former position as superintendent. Vice president and manager of Tuscarora since May, 1943, de Groot has been in the service of the company since 1919 following his release from the navy after the close of World War I

▸ **Gertrude M. Drach,** formerly with the PAW in Washington, has taken a position as geologist with the exploration division, producing department, Standard Oil Company of New Jersey. Miss Drach has served since August, 1941, with PAW, first on E. DeGolyer's personal staff, and later in the program planning department.

▸ **S. K. Clark** has been appointed chairman of Continental Oil Company's exploration committee, according to a recent announcement by President Dan Moran. Clark joined Continental in July, 1924, as a geologist after serving during World War I as a pilot in the air service and later being associated with several oil companies in Oklahoma and Kansas. He became assistant chief geologist for the company in 1932 and has served in that position until his recent promotion. He succeeds **R. E. Collom** who relinquished the exploratory job to devote full time to his duties as vice president in charge of Continental's California operations.

S. K. Clark

▸ **Paul James** has been appointed district manager of the Syracuse office, The Lincoln Electric Company, Cleveland, Ohio. He was graduated from Ohio State University in 1935 with a degree in electrical engineering and joined Lincoln Electric immediately afterward. He is a member of the American Society for Metals and the American Welding Society. **E. L. Smith** has been appointed district manager of the company's Rochester office to take the place of James.

▸ **R. W. Davis** has been appointed general manager of the Allis-Chalmers Manufacturing Company's Norwood, Ohio, works, according to President Walter Geist. Davis entered the Allis-Chalmers electrical department in 1910 after completing the company's graduate engineering training program. Previous to his appointment, he was assistant manager of the company's electrical department at Milwaukee, Wisconsin, but for the last 2 years has been on leave to serve as director of the electrical equipment branch of the War Production Board.

▸ **Edward J. Bullock,** a vice president and director of Standard Oil Company of Indiana until he retired in 1939 following 47 years' service with the company, has been appointed director in charge of District 2 PAW. He succeeds **W. W. Vandeveer,** president of Allied Oil Company of Cleveland, Ohio, who resigned to return to private business.

▸ **Jack W. Steele,** acting director of the petroleum conservation department, PAW, has resigned his position because of poor health. He had served in the interior department for almost 20 years, recently with headquarters in Amarillo, Texas. **Edward B. Swanson,** formerly associate director, has been placed in active charge of the division.

▸ **Harvey S. Mudd** of Los Angeles, California, president and managing director of the Cyprus Mines Corporation, located on Cyprus Island, has been elected president of the American Institute of Mining and Metallurgical Engineers.

▸ **Joe A. Huitt,** superintendent at Drumright for Deep Rock Oil Corporation, was reelected president of the Drumright chapter, division of production, the American Petroleum Institute at a meeting held recently at Drumright, Oklahoma. Other officers are **Joe H. Fields,** first vice president; **Guy Furman,** second vice president, and **D. J. Preston,** secretary-treasurer.

▸ **J. M. Wanenmacher,** area sub-surface engineer in charge of pool studies for the production department, Shell Oil Company, has resigned his position to join **C. H. Keplinger,** division engineer, in forming Keplinger and Wanenmacher, petroleum engineering consultants with offices in Tulsa, Oklahoma.

▸ **H. C. Weiss** of Houston and **Roy B. Jones** of Wichita Falls have been awarded the "distinguished service award" presented annually by the Texas Mid-Continent Oil and Gas Association to men in the Texas petroleum industry who have made outstanding contributions as citizens of the state, to the betterment of their home communities and to the petroleum industry and their own individual enterprises. Weiss, president of the Humble Oil and Refining Company, began his career in the Spindletop field near Beaumont, Texas. Jones, an independent operator, pioneered oil development in North Texas. He was once president of the Western Petroleum Refiners Association. Both have represented the industry in major capacities as members of committees to further the war program. The recipients of the award are selected each year by a committee representing all branches of the industry.

▸ **Morgan C. Daly** was named district manager for the Baroid Sales Division of the Tri-States area recently. His headquarters are in Tyler, Texas.

▸ **Major Melvin A. Smith,** who before entering the armed services was employed with the W. H. Curtin Company, Houston, Texas, recently returned to the United States on leave after spending 28 months in the South Pacific. He is a graduate of Texas A. & M. College with a degree in mechanical engineering. Now a major in the Second U. S. Marine Division, Smith participated in the battles of Guadalcanal, Talagi and Saipan. Wearer of the Presidential Unit Citation, Major Smith is now at the Marine Depot, San Diego, California, where he is awaiting further orders.

Maj. Melvin A. Smith

▸ **Whitney Weinrich** has resigned his position with the refining division of PAW in Washington, to join the research department of Phillips Petroleum Company at Bartlesville, Oklahoma, its engineering and development division. Before going with PAW, Weinrich was associated with Gulf Research and Development Company in Pittsburgh where he headed the chemical engineering and process laboratories.

▸ **Paul E. Bradfield,** since 1923 a Pacific Coast mechanical engineer specializing in power piping, has joined F. J. Hearty and Company, California representative of The Edward Valve and Manufacturing Company, Inc. Bradfield has been engaged in the public utility, consulting engineering, and valve and fittings fields.

▸ **George R. Lord,** formerly refineries manager for Sinclair Refining Company, has been elected vice president of the company, succeeding **George H. Taber,** recently named president. **John W. Duckett** was appointed refineries manager to succeed Lord.

▸ **A. W. McCoy III** has resigned from the staff of the Carter Oil Company and **A. B. McCullum** has resigned from the Superior Oil Company of California to join the staff of the Deep Rock Oil Corporation.

▸ **Otis O. Cole** has been elected president of South Penn Natural Gas Company, West Virginia subsidiary of South Penn Oil Company of which he was formerly vice president. Cole joined South Penn in 1911 as engineer and geologist. He will continue his duties as chief engineer and chief geologist for South Penn in addition to his new post. He succeeds the late **Noel Robinson.**

▸ **Frank M. Porter,** Fain-Porter Drilling Company, Oklahoma City, Oklahoma, was reelected president of the Kansas-Oklahoma division of the Mid-Continent Oil and Gas Association at the annual

meeting of the executive committee recently in Tulsa, Oklahoma. **Clarel B. Mapes** and **L. G. Owen** were renamed secretary-treasurer and first vice president, and all officers of the various divisions were reelected.

▸ **Freeman W. Burford,** former oil man of Dallas, Texas, has been promoted to the rank of colonel. He is a member of the general staff and is stationed at Paris.

▸ **Leo J. Mason** of Gary, Indiana, has been elected vice president of the National Tube Company. He has been associated with the company since 1918.

▸ **Sheldon Clark** has been elected chairman of the executive committee of Sinclair Oil Corporation succeeding the late E. W. Sinclair. **Albert Watts** has been elected executive vice president replacing Clark. Other changes in executive personnel include: **Leland V. Stanford** and **Watts** elected members of the board of directors, and **George H. Taber** promoted to the position of president of Sinclair Refining Company, a subsidiary.

▸ **Francis S. McIlhenny, Jr.** has been appointed assistant secretary and treasurer of Sun Oil Company, according to Frank Cross, secretary-treasurer. McIlhenny entered the employ of Sun in 1930 in the treasury department where he continued until joining the U. S. Naval Reserve in July, 1942. Serving in the rank of lieutenant, he has been personal aide to Rear Admiral M. F. Draemal, commandant of the Philadelphia Navy Yard. He is being released from the navy upon request by Sun Oil Company whose vast war program demands experienced employees.

▸ **Hugh R. Lambert,** formerly manager of sales, The Fluor Corporation, Ltd., has joined the staff of Yaras and Company as industrial sales engineer. Yaras and Company are exporters, importers, and manufacturers' representatives in Latin American countries and the Far East. Plans are now being made for reestablishment of engineering and sales offices, at the conclusion of hostilities, in the Philippines to cover the Dutch East Indies and Far East. Under Lamberth's direction will be the sale of heat exchangers, boilers, cooling towers, diesel engines, and other refinery equipment items as well as oil field specialties. The head offices of Yaras and Company are in Los Angeles, and a branch office in charge of **Fred R. Walter** is in New York. **J. V. F. D'Auvray** is in charge of the company's permanent office in Mexico City.

Hugh R. Lambert

▸ **Colonel Russell M. Riggins** who was recently granted a release from active military duty after serving for two years with the chief of ordnance, U. S. Army, Washington, D. C., has resigned his position as treasurer of Phillips Petroleum Company to engage in independent business practice. Colonel Riggins entered the employ of Phillips Petroleum Company in 1930. He served as comptroller until 1938 when he assumed the duties of treasurer. **B. F. Stradley,** formerly secretary and acting treasurer of the company, has been elected to succeed Riggins as treasurer. He will continue to serve as secretary for the company in addition to his new duties.

▸ **E. G. McKeever,** executive vice president of the Pan American Petroleum and Transport Company, has been elected president of that company, effective January 1. He will succeed **Robert E. Wilson,** who at the first of the year will become chairman of the Standard Oil Company of Indiana, which owns a controlling stock interest in Pan American. McKeever also has been named president of the American Oil Company, the Mexican Petroleum Corporation, and Lord Baltimore Filling Stations, Inc., marketing subsidiaries of Pan American. He will be vice chairman of Pan American's producing, refining, and pipe line subsidiaries. **D. J. Smith,** vice president of Pan American Refining Corporation for the last 12 years, will become president of that subsidiary on January 1. **P. J. Sweeny,** manager of the company's re-

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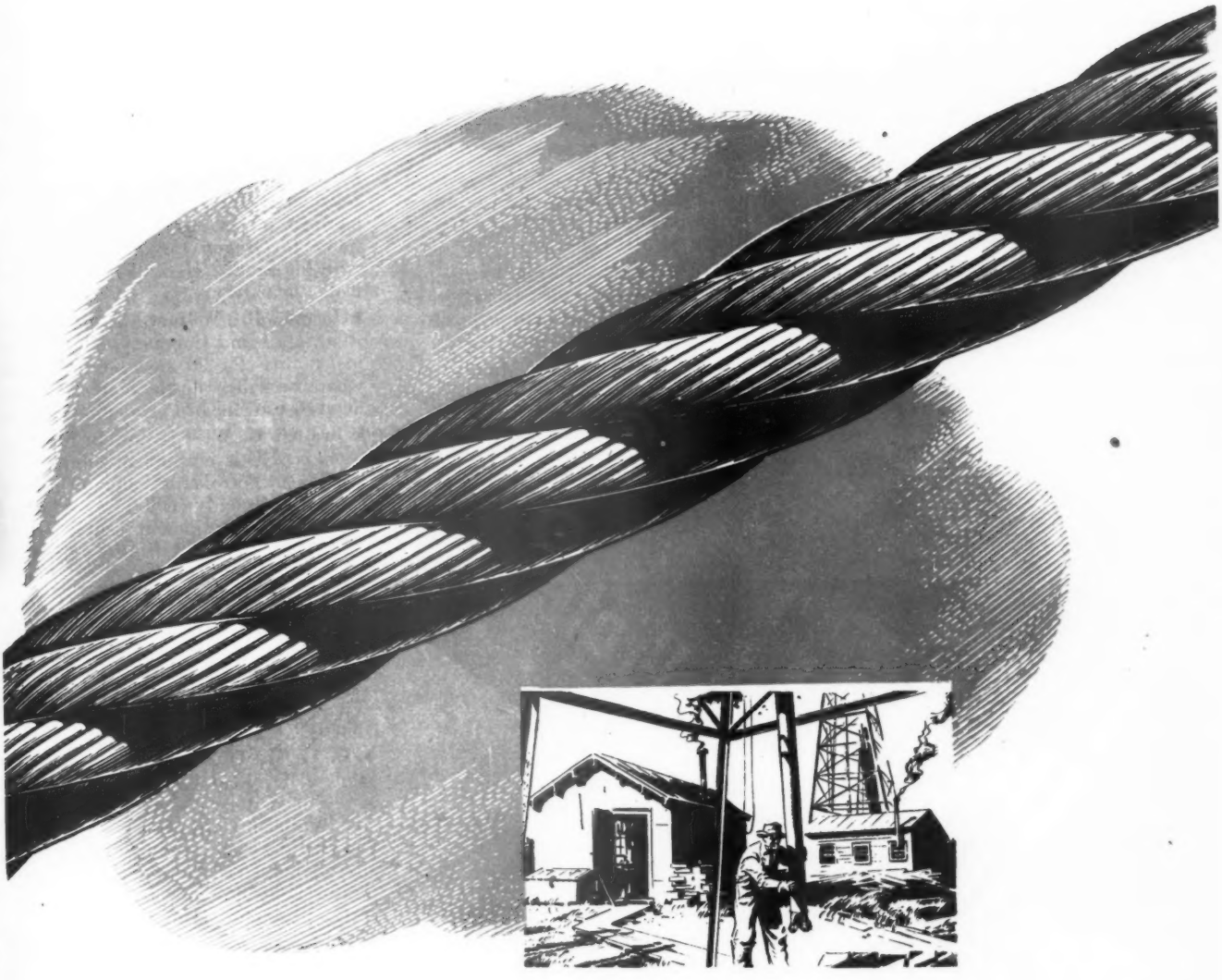

WHEN your purchasing agent first sees the quotation, he may say that Rochester Rope comes a little high . . . But when your wire rope made by Rochester is removed from service, your accountants will say that Rochester Ropes come low in maintenance costs . . . Rochester has always been classed among the best. And the best wire rope is always the cheapest . . . After the war, with two modern factories devoted to industrial requirements, the best will still be the cheapest! . . . Just remember the name—Rochester.

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finery at Texas City, Texas, will be made a vice president of Pan American Refining. **Charles E. Wagner,** general manager of the American Oil Company with headquarters at Baltimore, will be added to the board of directors for that company.

H. C. Creath, who has been with The Texas Company in Eastern Venezuela has recently returned to California.

L. S. Dawson, works manager for Oil Well Engineering Company, Ltd., Cheadle Heath, England, was a recent California visitor.

Chas. E. Davis of the executive staff of Arabian American Oil Company will return to Arabia in the near future. He has been spending a vacation with his family in California.

Arthur E. Eadie of Standard Oil Company of California will go to Venezuela for Richmond Exploration Company. He has had previous experience in Arabia.

Claude Goff of the drilling staff of United British Oilfields has returned to California from Trinidad because of the illness of Mrs. Goff.

Howard C. Keck of Iraq Petroleum Company will soon return to the Near East after spending a vacation in California.

Paul H. Molidor and Mrs. Molidor are now in California on vacation. He was formerly with Socony-Vacuum de Colombia at Canto Gallo in the Magdalene Valley of Colombia.

C. C. Von Elm, engineer for Mene Grande Oil Company in Eastern Venezuela has been in California studying drilling practices and equipment.

George S. Williams of International Petroleum Company at Negritos, Peru, stopped off in New York on his way home to Oregon for an extended visit with his family. He will return to Peru in the near future.

Frank R. Wilmer, formerly with E. B. Hall and Company, has left with his family for Maracaibo, Venezuela, where he will be in the material department of Caribbean Petroleum Company.

Francis G. West is now in Montreal, Canada. He is equipment engineer for Caribbean Petroleum Company at Maracaibo and recently visited New York and the oil field equipment centers of the Mid-Continent and California in the interest of his company.

L. W. Wiedey, executive of Tropical Oil Company in Bogota, Colombia, is now in California. He was formerly with International Petroleum Company in Peru. Wiedey is accompanied by Mrs. Wiedey and they will return to Bogota shortly.

E. Le M. Trafford, on the executive staff of Trinidad Leaseholds, Ltd., was a recent visitor to Canada and California. While in California he looked into the drilling and production phases of the oil industry. Accompanied by Mrs. Trafford, he has now returned to New York en route to Trinidad.

D. L. Adams has recently returned from Egypt where he has been with the Anglo-Egyptian Oil Company, Ltd. He is spending some time in the United States before taking another foreign assignment.

Conway Adney left in the early part of November for Eastern Venezuela where he will be in the service of the Mene Grande Oil Company.

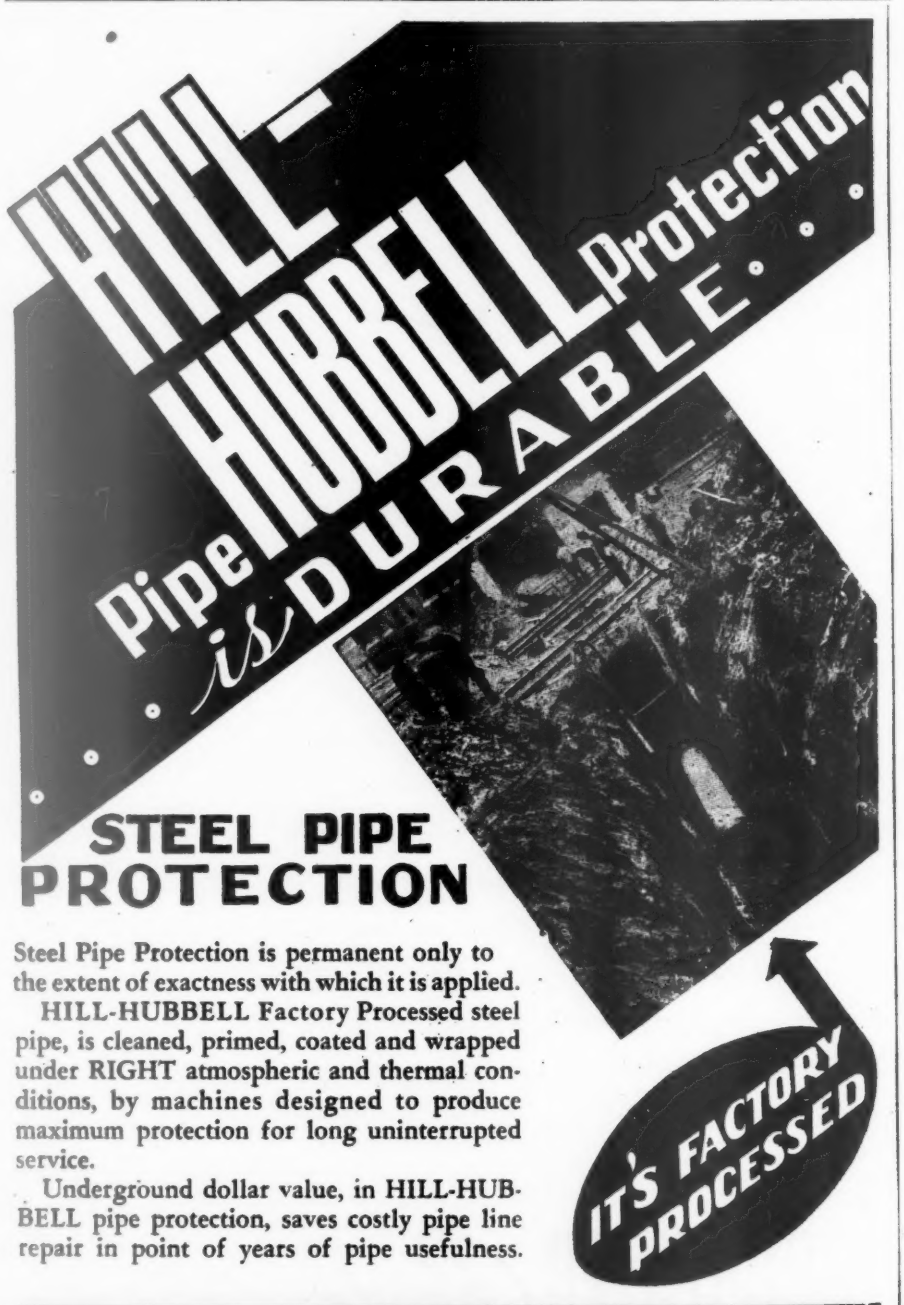
Gilbert N. Akin is now spending a well-earned vacation in California after a long assignment in the Persian Gulf fields with Iraq Petroleum Company, Ltd. and later in Egypt with the Anglo-Egyptian Oil Company, Ltd. He will return to the Near East for service with the Iraq Petroleum Company, Ltd.

V. C. Boston is now in California on leave but will soon return to El Centro, Colombia, where he is with the Tropical Oil Company.

R. L. Babcock will soon leave for Colombia to work for the Colombian Petroleum Company. He was formerly with the Iraq Petroleum Company in Iraq and spent a number of years in that country.

R. C. Sharp of Drilling and Exploration Company expects to leave California for Venezuela where he will serve that company's interests.

Russell W. Carter of International Petroleum Company, Ltd., Ecuador, will return to Ecuador within the next few weeks. He and his family are spending a vacation in California.



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Penn chief engineer

Donald G. Cameron, well-known electrical engineer, has been appointed to head the engineering department of Penn Electric Switch Company, Goshen, Indiana.

In selecting Cameron for this job, the company acquired the services of a man who is not only well-versed in scientific engineering design but is also experienced in modern manufacturing methods. Cameron, a graduate electrical engineer, formerly was associated for 15 years with General Electric Company, and in recent years was superintendent of that company's aircraft instrument division at West Lynn, Massachusetts.

Cameron, in his capacity of chief engineer, will be directly in charge of all engineering work on Penn's products, which include automatic controls for heating, refrigeration, pump and air compressor service as well as safety controls for internal-combustion engines.

Furfural supply easier

Furfural, widely used in solvent refining of lubricating oils, has been removed from the critical list of war materials according to advices received from Washington.

Furfural has been under allocation according to general preference order M-224 dated October 1, 1942. Due to its many important wartime uses, not only in the Furfural refining process, but also in the extraction of butadiene for the synthetic rubber program, WPB has carried it in Group I. This group includes critical materials, the supply of which is insufficient to fill existing military and essential industrial requirements.

Recent action of WPB indicates that the availability of Furfural has improved substantially, and accordingly has been placed in Group II, denoting that the supply is "sufficient for current military and essential industrial needs."

All civilian requirements, in addition to military and lend-lease orders, have been filled in September and October. Though still under allocation, the prospects are reported to be good for continuing to fill all essential needs.

Awards service pins

The third annual service pin banquet of the California division of Baker Oil Tools, Inc., was held recently coincidentally with nationally celebrated Navy Day. A total of 29 service pins were awarded for periods of employment of 5, 10, or 15 years, including the following employees now serving in the armed forces: R. G. Brandt, F. S. Fobes, G. H. Frahm, S. W. Martin, A. E. Pruett, Jr., C. B. Walker, R. N. Waters and E. W. Wilkins.

C. A. McDonald, production manager of the Huntington Park plant, and a 15-year man, made the acceptance speech on behalf of service pin recipients.

The highlight of the evening was a talk by Lt. Walter Kane on his experiences during the invasion of Saipan. An interesting sidelight to this banquet was announcement of the award to Baker Oil Tools, Inc., on October 21, of an added star to its Army-Navy "E" flag, for "continuing to maintain the high standard which you set for yourselves and which won you distinction more than six months ago."

Assistant division manager

P. C. Smith has been appointed assistant to manager of the transportation and generator division of the Westinghouse Electric and Manufacturing Company, according to an announcement by L. B. McCully, manager of that division.

Simultaneously, McCully announced the appointment of J. S. Askey, G. L. Moses, and P. G. Lessman as section engineers in the department.

Smith, a native of Capron, Virginia, attended the University of North Carolina, receiving a degree of bachelor of science in electrical engineering in 1921. He immediately entered the Westinghouse graduate student course and later the engineering and design schools. Since graduation from these courses he has worked successively in the motor engineering department, power engineering department, and the transportation and generator department. Since January of this year he has been assigned to special work in connection with power trains being built by Westinghouse at its New Philadelphia, Ohio, works.

New distributor set-up

Mixing Equipment Company, Inc., of Rochester, New York, manufacturers of Lightnin portable mixers and heavy duty Mixco agitators, has announced changes in its sales organization.

The Emerson Scheuring Tank and Manufacturing Company of Indianapolis, Indiana, manufacturers of stainless steel and special alloy vessels, will act as representative for central Indiana.

The White Industrial Sales and Equipment Company of Cincinnati, Ohio, E. V. White, president, will represent the company for southern Ohio, northern Kentucky, and western West Virginia, including Charleston.

Pacific Section A. A. P. G. meeting

The annual meeting of the Pacific Section of the American Association of Petroleum Geologists was held November 9 and 10 at the Ambassador Hotel, Los Angeles.

On the program were 11 papers, 9 of which were on phases of California oil geology. Many guests attended the Friday afternoon session to hear two talks of more general interest on the Middle East oil situation by Mortimer Kline, and on new oil and gas discoveries in California through the third quarter of 1944 by A. I. Gregersen, district geologist for PAW.

Dr. Judson Anderson of Johns Hopkins University described the geological setting of the oil fields of Colombia, South America. Dr. Anderson's visit to California was under the sponsorship of the distinguished lecturer committee of the American Association of Petroleum Geologists.

Another guest speaker was Dr. Norris Johnston, physicist of General Petroleum Corporation.

Glenn Bowes, Continental Oil Company, was elected president of the Pacific Section for the ensuing year. Robert T. White, Barnsdall Oil Company, was made vice president, and Vincent Vandiver, Seaboard Oil Company, was elected secretary-treasurer.

Army-Navy award

The Army-Navy "E" flag now flies daily over the factory of the George E. Failing Supply Company at Enid, Oklahoma.

Formal presentation ceremonies in which the "E" award was made to the Failing company were held recently with high ranking officers of the army and navy present, together with representatives of national, state, and city offices.

The Failing company has been engaged in the production of portable water well drilling units for the armed forces since the early days of the war and it was on the basis of their high efficiency record in delivering these units that the award was made.

Named comptroller

The Pittsburgh Plate Glass Company has announced the appointment of C. Robert Fay as comptroller, succeeding Stuart M. Campbell, resigned.

Fay has been secretary of the policy committee on war contract terminations for the Westinghouse Electric and Manufacturing Company since he returned last August after serving as consultant to the War Production Board on the controlled materials plan.

The new Pittsburgh Plate comptroller was born in Springfield, Ohio, but lived most of his life in Indianapolis before joining Westinghouse in 1925. He is a graduate of Purdue University.

Oil firm name changed

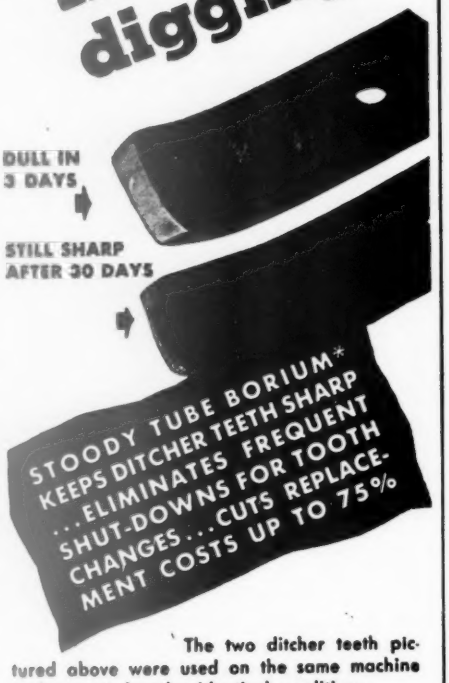
Change in the name of American Eastern Petroleum Company to American Overseas Petroleum Company has been announced.

The company, originally formed in July of this year, manages foreign exploration and development activities of companies jointly owned by Standard Oil Company of California and The Texas Company with the exception of their Arabian and Bahrein interests.

American Overseas directs exploration and development of properties in Egypt, New Zealand, and Australia, and will include the Netherlands East Indies after liberation from Japan.

Officers of American Overseas are: E. A. Skinner, president and director; E. M. Butterworth, vice president and director; F. C. Sealey, vice president and director; J. H. MacGaregill, director; C. E. Olmsted, director; H. G. Parker, secretary-treasurer, and H. J. Hawley, manager of exploration. Headquarters are in San Francisco.

Tube Borium Keeps 'em digging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STOODY TUBE BORIUM* KEEPS DITCHER TEETH SHARP ...ELIMINATES FREQUENT SHUT-DOWNS FOR TOOTH CHANGES...CUTS REPLACEMENT COSTS UP TO 75%

The two ditcher teeth pictured above were used on the same machine and operated under identical conditions.
The unprotected tooth at the top had to be sharpened every three days and was too short for further service after six sharpenings.
But the Borium-protected tooth at the bottom operated for 40 days and wore only ½". It was simply resharpened in the forge, retipped with Tube Borium, and put back on the ditcher for another 40 days' service.
Before the tooth was finally worn out, it had operated a total of 120 days!
Tube Borium makes such savings possible because the deposits represent the ultimate in wear resistance and the ability to cut hard earth formations.

*Stoody Tube Borium is supplied in rods of ⅛", 5/32", ¼" and ⅜" diameters and is available for either oxyacetylene or D.C. electric application. Prices and specifications are yours for the asking.

These tungsten carbide particles do not melt when tube is applied but are held in suspension in a mild steel matrix forming a deposit resembling coarse sandpaper.

Send for free booklet on TUBE BORIUM, showing sizes and styles of rods and recommended methods of application.

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1142 West Slauson Ave., Whittier, Calif.

STOODY HARD-FACING ALLOYS
Stop wear... Eliminate Repair

LAUGH WITH BARNEY

A Washington hotel clerk told the three SPARS he was sorry no rooms were available, but if they didn't mind sharing a room with three sailors it might be arranged. Later three WAVES came in and again the accommodating sailors agreed. To add to the clerk's distress a helpless but beautiful blond appealed for shelter. The sailors again proved their hospitality. . . . The next morning the three sailors came into the breakfast room and each ordered a doughnut and a cup of coffee. They were soon followed by the SPARS and then the WAVES—each ordering doughnuts and coffee. Finally the blonde appeared, evidently rested, and ordered a doughnut and a cup of tea. . . . It just goes to show that nine people out of ten drink coffee for breakfast.

They tell me in Mexico you can get three pounds of sugar, a pound of coffee, a quart of whisky and a wife for three dollars. I'll bet it's rotten whiskey.

"I had to change my seat several times at the movies."
"Gracious, did a man get fresh?"
"Well, finally."

Father (at ball game): "Son, here comes a great player."
Son: "Pop, he's no good. I heard Mom tell him he couldn't get to first base."

"You've got nerve to ask me to let you marry my daughter Flossy! Why, you couldn't even keep her in underwear!"
"Well, Mr. Rich, I haven't seen anything that indicates that you have been doing so well yourself."

The flood was over and Noah thought he had freed all the animals; returning to the ark, however, he found two large snakes crying in a corner. He asked: "What's your trouble; why all the sorrow?"
They replied: "You told us to go forth and multiply upon the earth, and we are only adders."

He: Are ye fond of moving pictures, Jennie?
She: Aye, Sandy.
He: Then maybe, lass, ye'll help me get half-a-dozen doon out the attic.

"Brothers," said the colored preacher, "the subject of mah sermon today is liars. How many in dis congregation have read the sixty-ninth chapter of Matthew?" Nearly every hand went up.
"You is the people ah wants to preach to," the reverend said. "Dere is no such chapter."

"So you and your boy friend were automatically married?"
"Yes, my pa has one."
"One what?"
"An automatic."

Doctor: Ever had any trouble with dyspepsia?
Recruit: Only once, sir; I tried to spell it.

Two little girls were sitting on the curb in front of a house.
"My sister is getting married tomorrow."
"Yeah?"
"Yup. She's upstair now getting her torso ready."

"Mother, may I keep a diary?"
"Why, yes dear."
"Then may I do the things to write in it?"

"What is a budget?"
"Well it's a method of worrying before you spend instead of after."

Give an athlete an inch and he'll take a foot. But let him take it. Who wants athlete's foot?

The doctor was visiting Rastus' wife to deliver her twelfth offspring. While riding along with Rastus he saw a duck in the road.
Doctor: Whose duck is that?
Rastus: That ain't no duck. That's the stork with his legs wore off.

Upset Young Thing: I've been misbehaving and my conscience is bothering me.
Doctor: Should I give you something to strengthen your will power?
Upset Young Thing: No, give me something to weaken my conscience.

Air Raid Warden: I'm awfully sorry, old man, that I arrested you for kissing a woman in the blackout. I didn't know it was your wife.
Man About Town: Oh, that's all right, Warden, I didn't know it either until you flashed that light in her face.

Father: Why were you kept in at school.
Son: I didn't know where the Azores were.
Father: Well, in the future just remember where you put things.

An old retired lumberman had taken a room in a hotel and was preparing for bed. Just as he slipped under the covers and was reaching to turn out the light, the door opened unexpectedly and a radiant young blonde bounced into the room.
"Oh, excuse me," she cried. "I must have gotten into the wrong room."
The old man looked at her sadly: "Not only the wrong room, young lady, but you got here about forty years too late.

Along with the old shoes tied on the back of the newlyweds car was a sign which read—"Amateur Night."

Debutante (telephoning home at 3:30 a.m.): "Don't worry about me, mom, I'm O.K. I'm in jail."

My lady, be wary of Cupid
And list to the lines of this verse:
To let a fool kiss you is stupid,
To let a kiss fool you is worse.

Private: Who introduced you to your wife?
Sgt.: We just met. I don't blame nobody.

Mary, aren't you getting too big to play with the boys?
No, mother, the bigger I get the better I like them.

The school boy whose first love was baseball was writing answers to an anatomy test: "Your leg is what if you ain't got two pretty good ones you can't get to first base, and neither can your sister."

Call it what you like
CORE EXTRACTOR or TESTING PUMP

It's the handiest little outfit you ever had around!

It has dozens of uses in both field and shop

The Baker Hydraulic Core Extractor and Testing Pump is a strong, simply constructed light-weight unit capable of developing pressures up to 6,000 pounds, without undue exertion.

Originally designed for removing cores from core barrels, many other oil field and shop uses have been discovered and it is today widely used as a testing pump; for removing plungers from insert liner oil well pumps; for testing valves, fittings, casing and tubing; and for setting Baker Cement Retainers when mud or cement pumps are not available.

LOW OR HIGH PRESSURE

The Baker Hydraulic Core Extractor has two pistons, one for low pressures and one for high pressures, the change being quickly made by merely moving the pressure shifter to engage the proper lugs for pressure desired.

LASTS INDEFINITELY WITHOUT REPAIRS

Simple, rugged construction insures long, trouble-free service, and by pumping clear water (or water containing soluble oil) through the unit after use, the essential working parts always function properly and seldom require replacement.

The Baker Hydraulic Core Extractor and Testing Pump is identified as Product No. 540, and is described in detail on Page 374 of the 1944 Baker (or Composite) Catalog.

BAKER OIL TOOLS, INC.

Houston—LOS ANGELES—New York

The BAKER Hydraulic

CORE EXTRACTOR AND TESTING PUMP • PRODUCT NO. 540

Greater Power Yield
Lower Fuel Outlay

Longer Equipment Life
When you standarize on

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to automatically and safely remove and prevent boiler scale and corrosion.

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Export Representatives
PETROLEUM MACHINERY CORP.
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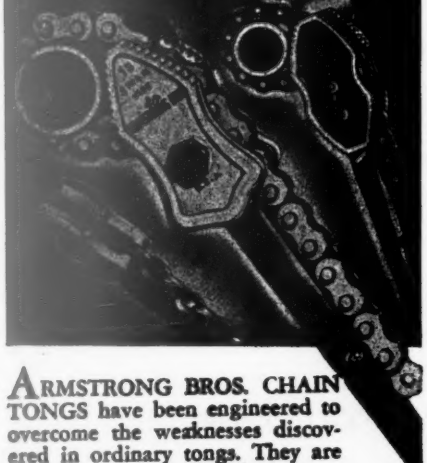
Look for the Arm-and-Hammer
ARMSTRONG BROS.
CHAIN TONGS



ARMSTRONG BROS. CHAIN TONGS have been engineered to overcome the weaknesses discovered in ordinary tongs. They are stronger, last longer and are more convenient.

Jaws are drop forged, with milled teeth, are heat-treated and extremely tough. They have inner lugs which increase the bearing on the bar and also prevent chains from jamming. Other strength features include forged handles, large hardened steel bolts, alloy steel shackles and proof-tested chains.

ARMSTRONG BROS. Tongs come in *all* standard types, each in *all* sizes.

Write for Catalog.

ARMSTRONG BROS. TOOL CO
"The Tool Holder People"
CHICAGO, U.S.A.

Export representative

Le Roi Company, Milwaukee, Wisconsin, manufacturers of internal-combustion engines, portable air compressors, and engine-driven generator sets, announces the appointment of Russell D. Heath of New York City, as their export petroleum industry representative.

R. D. Heath

Heath was formerly connected with the Westinghouse Electric International Company for more than 20 years, in charge of export petroleum and mining industry sales. He has an intimate knowledge of petroleum operations throughout the world and has for many years been closely connected with the major oil companies' export offices in New York, analyzing their requirements and preparing technical data applying to all phases of oil field operations. He has traveled extensively in South and Central America, and is intimately familiar with petroleum operations in Mexico, Trinidad, Venezuela, Colombia, Ecuador, and Guatemala.

Society celebrates

The Western Society of Engineers celebrated the 75th anniversary of its founding on December 5 in the Grand Ballroom of the Sherman Hotel, Chicago.

The society was founded in 1869 and is the third oldest engineering society in the United States.

The purpose of the society as defined in its constitution, is the advancement of theory and practice of engineering, the improvement of the status of engineering practice as a profession, and maintenance of high professional standards. It represents all branches of the engineering profession and among the society's membership are representations from virtually every type of business organization and institutions of the nation.

The society has collaborated with the various engineering organizations on matters of national scope. During the past several years it has acted as sort of a post-graduate school whereby engineers were enabled to keep abreast of the latest developments in engineering science, by means of the reading of various papers and discussions of engineering interest. This was accomplished by holding meetings at least once a week, and by the various inspection trips to plants and projects of special interest. The society deserves special mention of its library, which is one of the most outstanding engineering libraries in this country.

The society administers or participates in four major honorary awards having as their purpose the recognition of engineering accomplishment. These awards are the Octave Chanute Medal, The Washington Award, The Charles Ellet Award, and the Alfred Noble prize.

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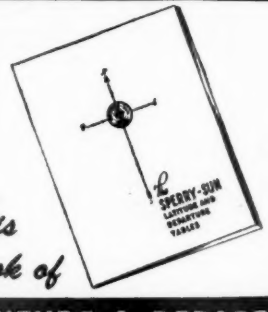

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LATITUDE & DEPARTURE TABLES

Immensely Valuable to Petroleum Engineers

An accurate survey of a bore hole involves over 100 records. The calculations involve considerable time with possibility of errors.

Sperry-Sun Well Surveying Co. has compiled a set of Tables at great effort and expense which completely eliminates the making of calculations and immediately furnishes the desired results. So many requests have been received for their publication that Sperry-Sun has agreed to their release because of their usefulness to the oil industry. The book also contains a section dealing with the correction of Magnetic Compass Records.

PRICE $5.00

Address orders to:
THE PETROLEUM ENGINEER
Box 1589 Dallas, Texas

Dickey chief engineer

Bailey Meter Company, Cleveland, Ohio, announces the appointment of P. S. Dickey as chief engineer. Dickey will supervise all engineering, research, and design activities for the company, and will be assisted by H. H. Gorrie, assistant chief engineer, and R. E. Clark, manager of contract engineering.

In his former position of research engineer, Dickey has conducted numerous studies here and abroad on the problems involved in the control of both forced and natural circulation boilers in stationary, marine and mobile service.

Dickey is a mechanical engineering graduate from Purdue University and has served Bailey Meter Company continuously in various engineering capacities since his graduation in 1925.

H. H. Gorrie is a graduate of Rensselaer Polytechnic Institute and has been associated with Bailey Meter continuously since his graduation in 1927.

R. E. Clark is a graduate of the University of Kentucky and has completed more than 20 years' service with Bailey Meter Company.

Head offices moved

Dresser Industries, Inc., a $35,000,000 enterprise and one of the country's largest manufacturers of equipment for the oil, gas, and industrial fields, will move its headquarters from Bradford, Pennsylvania, to Cleveland Ohio, H. N. Mallon, president, announces. Executive offices will be located there in the Terminal Tower.

Cleveland already is the home of a Dresser Industries' member company, The Bryant Heater Company, and of an affiliate, Van der Horst Corporation of America. Dresser Industries, Inc., is the parent corporation of a group now comprising 10 companies, all in related lines of manufacture.

The factory of the Dresser Manufacturing Division at Bradford, up to now the parent corporation of the Dresser group, will remain in Bradford and operate as Dresser Manufacturing Division of Dresser Industries, Inc. Other member companies in addition to those in Cleveland include Clark Bros., Inc., Olean, New York; Pacific Pumps, Inc., Huntington Park, California; International Derrick and Equipment Company, Columbus, Delaware, and Marietta, Ohio, Beaumont, Texas, and Torrance, California; Roots-Connersville Blower Corporation, Connersville, Indiana; Stacey Bros. Gas Construction Company, Cincinnati, Ohio; Bovaird and Seyfang Manufacturing Company, Bradford, Pennsylvania, and Dresser Manufacturing Company, Ltd., Toronto, Ontario.

Deep well cement

In the article on Standard Oil Company's well KCL 20-13, breaker of the depth record, November issue, *The Petroleum Engineer*, a list of equipment manufacturers was given. From this list was omitted Colton high temperature oil well cement, which was used to set the 7-in. casing at 10,999 ft.

SHAKING TROUBLE OUT OF A TEXAS WILDCAT . . . Shale and other damaging cuttings picked up in drilling mud, are a source of no small problem, cluttering up slush pumps and rotary hose and breaking up the consistency of the mud. Tons of this natural nuisance are circulated out of many extremely deep holes. The Link-Belt Mud Screen pioneered the job of ridding otherwise safe, efficient drilling mud of this trouble-maker, and operators the world over accept it as the No. 1 method of reconditioning rotary drilling fluid. Pictured here is a Link-Belt Type NRM-124 Dual Mud Screen, driven by a single turbine (or electric motor) and operated either singly or as a dual unit, according to fluid load requirements. Send for folder 1872-A.

LINK-BELT COMPANY

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Los Angeles Nomads

Tales of the old army in the Philippines, just after the United States took it over many years ago, entertained the 92 members and guests at the regular dinner meeting of the Los Angeles chapter of Nomads held at the Mayfair Hotel in Los Angeles. President Roland Smith opened the meeting with the pledge of allegiance to the flag and then announced the following names of men selected by the membership to serve on the nominating committee for 1945 officers: Bill Bettis, Hi Cassidy, Elmer Decker, and Ted Sutter, members; Web Wilson, Earl Daniels, Al Farrow, and Custer Morrow, alternates.

The master of ritual, Hi Cassidy, found only two of the five initiates on hand but proceeded to give these two, H. K. Browning and Larry Coker, both associate members, "the works."

The meeting was then turned over to the master of ceremonies for the evening, George Anderson, who introduced the first speaker, Lt. Larry Kelley of the U. S. Navy. Lt. Kelley has been a P. T. boat commander in the South Pacific action and told of his experience before he was wounded and sent back to the States for hospitalization. The main speaker of the evening was Major George Steunenberg, U. S. Army, retired, who saw plenty of action in the old days. He was present at the raising of the flag at Hawaii and was selected to raise the flag in the Philippines. Fortunately for him he could not locate a flag because the officer who did raise it got killed with a sniper's bullet.

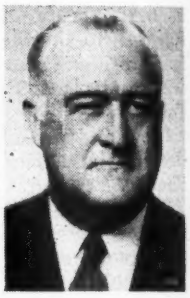
After a brief intermission, war pictures with sound were shown.

Among those present were G. L. Kothny of the New York chapter and C. E. Whitney of the Houston chapter. Also in attendance was Charles Potter of the Richmond Petroleum Company from Venezuela, one of the Chapter's honorary members.

Among the foreign guests at the meeting were: V. C. Boston and L. W. Wiedey of the Tropical Oil Company from Colombia; C. E. Davis of the Arabian-American Oil Company from Saudi, Arabia; E. L. M. Trafford of Trinidad Leaseholds from Trinidad; G. N. Akin and H. C. Keck of the Petroleum Development Company from Qatar; H. C. Creath of The Texas Company from Venezuela; R. L. Babcock of Colombian Petroleum from Colombia; Art Eadie of Richmond Petroleum from Colombia, and F. G. West of Caribbean Petroleum from Venezuela.

Eastern sales manager

James E. Power has been appointed eastern sales manager of the mechanical goods division, United States Rubber Company, it is announced by Herman A. Everlien, general sales manager of the division.



J. E. Power

Power began his career with the company in 1906 as an office boy. Five years later he became a salesman, and in 1926 he was appointed manager of the New York branch of the mechanical goods division. He interrupted his career during World War I to join the United States Navy, returning to his post in 1919, and later becoming assistant manager of branch sales.

Assistant sales manager

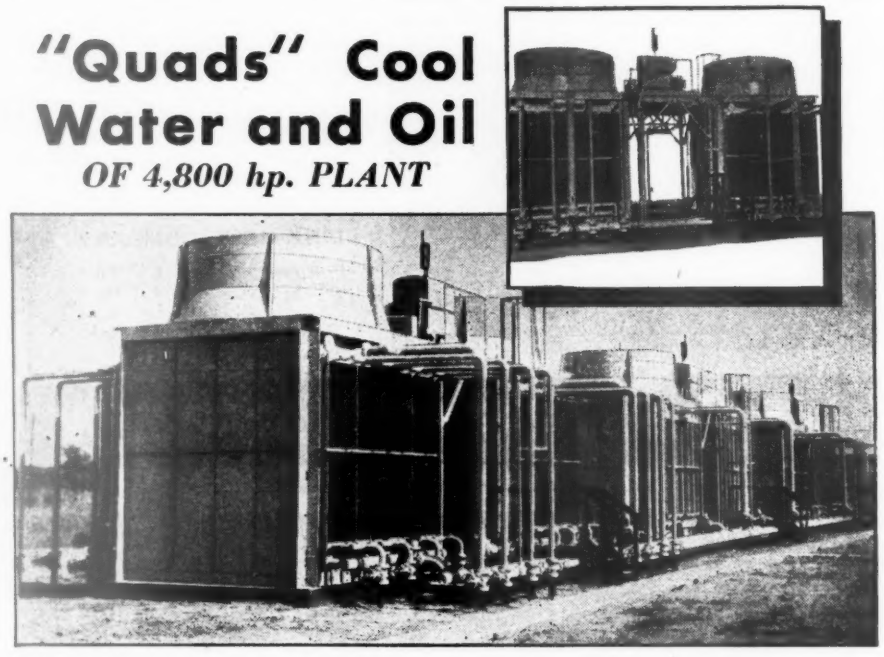
A. M. Buxton has been promoted to assistant sales manager of The Cooper-Bessemer Corporation, it is announced by S. E. Johnson, general sales manager, with headquarters at Mount Vernon, Ohio.

A. M. Buxton

In addition to sharing responsibilities of the general sales manager, Buxton will direct the company's oil and gas field sales, according to Johnson. He has been working closely with these fields in his former position at the company's Tulsa office.

Buxton has been with Cooper-Bessemer for 20 years.

"Quads" Cool Water and Oil OF 4,800 hp. PLANT



★ The above battery of Young-Happy "Quad" Coolers maintains the jacket water and lubricating oil of eight 600 hp. v-angle compressors and driving engines at suitable operating temperatures. This installation at a Southern Illinois refinery* for the production of Iso-Butane and Butane has been in successful operation for more than a year. Four of the six units have oil cooling sections mounted in front of the jacket water cooling cores. Auxiliary engines (each serving two units) rotate 10 ft., especially designed, induced draft fans through right angle speed reducers. At present, cores are installed in only two sides of each "Quad", leaving room for increased cooling capacity to take care of future plant expansion. Write for complete engineering data.

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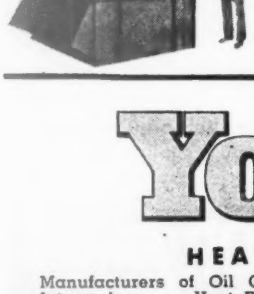
*Three "Quad" Condensers are used to condense 40,000 lbs. of steam per hour at 10 lb. gauge pressure.



Young "Quad" Coolers and Condensers function on the same principle as automotive radiators—there are no water losses or external pumping heads. Where temperatures below the ambient dry bulb are required Young evaporative type units (left) may be used independently or supplementary to "Quads". Minimum operating costs and water make-up requirements are assured with these efficient evaporative coolers and condensers.

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Opens New York office

Dean Swift

Dean Swift, formerly of Seattle, announces the opening of offices in New York City. He will represent the Western Gear Works' plants at Seattle, Washington, Lynwood and Vernon, California, and Western Gear's associate plant, the Pacific Gear and Tool Works of San Francisco.

The Western Gear plants are manufacturers of all types of gears and geared machinery. Their products include speed reducers, marine propulsion units, cranes and crane machinery, winches, hoists, deck machinery, capstan gearing, airplane gears and actuating units, ship lighting sets, various types of transmissions and oil field pumping equipment. Swift's offices are in the Chanin Building, 42nd and Lexington, New York 17, New York.

To manage New York division

O. B. Wilson has been named New York industrial manager for the Brown Instrument Company, precision industrial instrument division, Minneapolis-Honeywell Regulator Company. His appointment becomes effective the first of the year.

Wilson has been with the Brown company for 21 years during which time he has served in several branch offices throughout the country and at the company headquarters at Philadelphia. Wilson is being transferred from the Chicago branch where he has been industrial manager for the last several years. He will make his new headquarters at the Honeywell New York office.

J. A. Robinson has been named industrial manager of the Chicago branch to succeed O. B. Wilson.

Robinson has been with the Brown organization 15 years. He has represented the company in several territories and for the last several years has been connected with the Chicago branch.

Moyer made controller

Parkhill-Wade, consulting and construction engineers, 1625 South Alameda Street, Los Angeles, California, has announced the appointment of Sam E. Moyer as controller of that company, effective October 20, 1944.

Sam Moyer is well known in the oil industry, having been associated with the oil business in California for 20 years. He held the position of chief accountant of the Kettleman North Dome Association for the past 13 years prior to assuming his new duties as controller for Parkhill-Wade.

Howard Gay dies

Howard Gay, 51, secretary and cost department manager of Macwhyte Company, wire rope manufacturers, Kenosha, Wisconsin, died November 23 after an extended illness.

Born in Meshoppen, Pennsylvania June 1893, Howard Gay attended schools there and was graduated from Wharton Extension University School of Pennsylvania.

New positions announced

Ernest G. Brown, general manager of the mechanical goods division, United States Rubber Company, announces the appointment of Herman A. Everlien as general sales manager of the division and Walter F. Spoerl as merchandise manager. Both positions are newly created.

Everlien has had more than 41 years experience in the mechanical rubber goods industry, Spoerl 36 years. Both men began their rubber careers at early ages as clerks in the sales department of the old Revere Rubber Company in Chicago, later consolidated into the United States Rubber organization.

Representative appointed

Fisher Governor Company, Marshalltown, Iowa, announces the appointment of Malcolm W. Black and Company, as its representative in metropolitan New York and surrounding territory, including Connecticut and northern New Jersey. The appointment became effective December 16. Offices have been established at 41 East 42nd Street, Room 520, New York City.

Black, a graduate electrical engineer from the University of Oklahoma, has been associated for the last 10 years with Manning, Maxwell and Moore in the Tulsa, Oklahoma, area.

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These duplex pumps are our most popular design. These pumps have proven their dependability over long periods. The use for this type pump originates in Refineries, Power Plants, Buildings, etc. Over 90 years of design experience has been incorporated into these models, ruggedly constructed, efficient in operation. Maintenance costs are very small, and in places where process steam is used, liquid transfer is most economical.

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7½ x 5 x 6	6 x 6 x 6
7½ x 4½ x 10	6 x 7 x 6
7½ x 5 x 10	7½ x 7 x 6
10 x 6 x 10	7½ x 6 x 10
10 x 7 x 10	7½ x 7 x 10
10 x 6 x 12	8 x 8½ x 10
10 x 7 x 12	10 x 8½ x 10
12 x 7 x 12	10 x 8½ x 12
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Heads Rockford Drilling

Announcement of the election of Arch A. Warner as president and general manager of Rockford Drilling Machine Division of Borg-Warner Corporation at Rockford, Illinois, has been made in Chicago.

Warner, former works manager of Mechanics Universal Joint Division of the corporation, also at Rockford, succeeds E. C. Traner, who at his own request has retired from active management of the company to become chairman of its advisory board. Before going to Rockford in 1941, Warner was sales engineer at Detroit for Mechanics, which he joined in 1938.

Prior to his connection with Borg-Warner Corporation, Warner was with Universal Products for 10 years and for almost as long a period engaged in engineering and sales development work on carburetors for both the Zenith and Stromberg organizations.

Traner, born at Rockford in 1876, is one of the veteran manufacturers of the Borg-Warner organization. On March 1, 1916, he and a group of associates took over the Rockford Drilling Machine Company, with Traner first serving as secretary and treasurer and later as president and general manager.

He continued in the latter capacity after the company was purchased by Borg-Warner in 1929.

Chiksan sales manager

L. J. Laird

Lee J. Laird, formerly assistant sales manager and recently in charge of production control, has been appointed sales manager of Chiksan Tool Company, Brea, California. In addition, Laird becomes vice president of the company.

Laird's experience during 10 years as a member of the Chiksan organization fully qualifies him for his new responsibilities. He is widely known both in the petroleum industry and among manufacturers in many other lines of industry. Laird successfully introduced Chiksan aero hydraulic swivels to the aircraft industry, resulting in the adoption of these units as standard equipment on a number of combat and transport planes.

Under Laird's direction, extensive plans are under way to develop many new applications for Chicksan ball bearing swivels as well as new types of swing joints.

Opens Dallas branch

Penn Electric Switch Company, with main offices at Goshen, Indiana, has opened a branch at Dallas, Texas, to serve the Southwest.

The new office is in charge of Ray P. Waite, graduate mechanical engineer who has had considerable experience in electrical and chemical engineering. Waite was in the public utility business until 1932 at which time he was vice president and general manager of a midwest utility company. Since 1932 he has been engaged in consulting engineering and in this capacity has done sales, sales promotion, and product research work. Waite's experience also includes oil production and refinery design and construction, as well as design, construction, and operation of chemical plants, industrial plants, and commercial buildings.

Firms names changed

The name of Pacific Pump Works, Huntington Park, California, has been changed to Pacific Pumps, Inc., and the name of Mid-Continent Pump Supply Company, Tulsa, Oklahoma, has been changed to Pacific Pumps, Inc., Mid-Continent Division, according to a recent announcement.

Opens sales office

The Republic Supply Company has announced the opening of a sales office at 312 Pure Oil Building, 35 East Wacker Drive, Chicago, Illinois, under the management of Wm. Skakel.

TRADE LITERATURE

Publications listed are sent free upon request.

The National Supply Company has issued two pamphlets showing and describing two pieces of new equipment, *type "A" casing support* and *casinghead*, which were recently placed on the market. Not only do the leaflets show the new equipment, but they also have charts giving measurements and dimensions together with drawings and diagrams showing the simplest methods for using the new pieces. Further information on these two items may be obtained by writing The National Supply Company, Pittsburgh, Pennsylvania, and asking for bulletins 310 and 311.

An attractive booklet called "*Universal Processes*" has just come off the Universal Oil Products Company's press. It describes the various methods by which Universal strives to maintain standards and develop research for the purpose of aiding the oil industry. Among the topics treated in the booklet are catalytic cracking, reforming, hydrogenation, alkylation, isomerization, thermal cracking, hydroforming, dehydrogenation, polymerization, Unisol treating, retreating, and polytreating. Also included are a number of pictures and drawings. This material is available from Universal Oil Products Company, Chicago 4, Illinois.

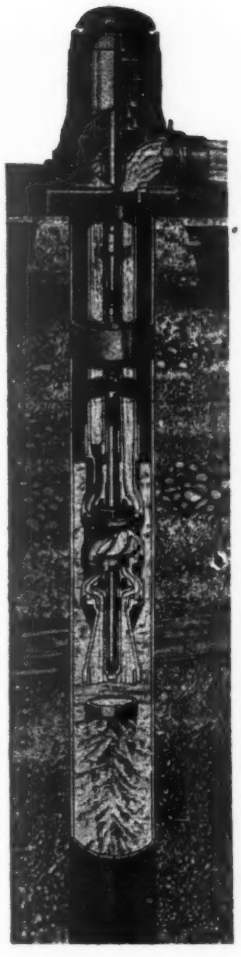
The physical and chemical properties of and the principal uses of *anhydrous ammonia* are pointed out in a new booklet by The Barrett Division of Allied Chemical and Dye Corporation. Complete with graphs, drawings, and pictures the story of this synthetic liquefied gas is told in detail. Also included is information on the way the product may and may not be handled, with the notation that a blueprint of equipment for unloading anhydrous ammonia will be sent anyone requesting it. Further information may be had from the company at 40 Rector Street, New York, New York.

A new bulletin, number 501, describing the separation of suspended solids and the application of *Merco Centrifugals* has just been released by Merco Centrifugal Company. The booklet lists the three ways by which Merco centrifugals may be applied to the separation of solids. It is complete with drawings, diagrams and pictures. A copy of the booklet will be forwarded by the manufacturer upon request to Merco Centrifugal Company, Hobart Building, San Francisco 4, California.

Fisher Governor Company of Marshalltown, Iowa, has just released a new booklet on the subject of "*Time Temperature District Gas Regulators*" written by Charles D. Peterson of that company. The book is detailed in its description of the application and operation of this type of control equipment and is fully illustrated with drawings and installation photographs. Copies may be procured by writing to Fisher Governor Company, Department A, Marshalltown, Iowa.

Air Reduction, manfacturer of welding equipment and gases, has issued a new bulletin on *acetylene generators*. It features the new Airco type "P" portable generator, together with descriptions and illustrations of the company's complete line of generators, including portable models in 15, 30, and 50 lb. sizes with 30, 60, and 100 cu. ft. maximum hourly productive capacity. Copies of the bulletin may be had from any Air Reduction office or by writing the company's general offices at 60 East 42nd Street, New York 17, New York.

A new folder in two colors, titled "*Amercoat No. 33 Plastic Coating*," describes the properties, uses, and benefits of this general-purpose, cold-applied, protective coating. It features a complete list of corrosive agents to which Amercoat No. 33 is impervious. Technical facts presented range from application, coverage, colors, to degrees of weathering, moisture absorption and transfer, and resistance to chemical fumes, splash and overflow of acids, alkalies, salts, oils, water, etc. Many proven uses in a wide spread of industries are described. Write Amercoat Division, American Pipe and Construction Company, P. O. Box 3428, Terminal Annex, Los Angeles 54, California, for further information.



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Joins Bucyrus-Erie

Appointment of G. E. (Bert) Ponder, Odessa, Texas, to a position in its drill sales organization was recently announced by Bucyrus-Erie Company, South Milwaukee, Wisconsin. He will be stationed at the company's Dallas, Texas, office in charge of oil well spudder sales in the Dallas territory.

Ponder brings to his new position more than 16 years' experience in the cable-tool drilling field. His background includes association with such prominent firms as International Supply Company and Bethlehem Steel Company. Immediately before joining the Bucyrus-Erie organization he had been conducting his own drilling and well-servicing business at Odessa.

At the service of Bucyrus-Erie customers and prospects in the Dallas territory, Ponder will work closely with authorized Bucyrus-Erie distributors to render sound assistance on drilling equipment problems. His appointment became effective November 1.

Heads Petroleum Geologists

The Dallas Petroleum Geologists have selected Henry C. Cortes of Magnolia Petroleum Company as president for 1945. He succeeds Joseph M. Wilson, independent operator, who becomes a member of the executive committee. Other new officers elected were Cecil H. Green, Geophysical Service, Inc., vice president, and Willis Meyer, DeGolyer and MacNaughton, secretary-treasurer. Henry Morgan, Atlantic Refining Company, was named to the executive committee. New officers were selected by mailed ballots and were announced recently at a meeting in the Baker Hotel, Dallas, Texas.

Rader joins Dia-Loy

C. M. Rader

C. M. Rader, widely known petroleum engineer, has become associated with the Dia-Loy Tubing Survey Company of Whittier, California, as general sales manager in charge of western territory.

Rader has been identified with the oil production and supply industries for the last 24 years, having served in various capacities in the Rocky Mountain, Mid-Continent, and California fields. Most recently he was associated with Kobe, Incorporated of Huntington Park, California, with which company he held an executive position for several years.

In his new connection Rader will supervise promotion and development of oil field service for the Dia-Loy company, which has specialized in making surveys of tubing and casing to determine the reduction of wall thickness from excessive wear, corrosion, electrolytic action, etc.

Three serve 96 years

A total of 96 years of continuous employment, divided almost equally, is represented by three men now with the service division of the Brown Instrument Company, Philadelphia manufacturer of precision industrial instruments.

The youngest in point of service is Herbert Bohle who received the company's 30-year service pin in October. The other two are Earl M. Robinson, in charge of the service division of the Brown branch of Minneapolis-Honeywell Regulator Company, and Earl D. Nuneviller special field representative. Both have served the company for 33 years and both are veterans of the first World War.

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Sales representative for Midcontinent Sales Engineering position. Must have had distributor sales experience in specialty products. Must travel. Position offers good future with well known service company. Send full particulars, including personal information, experience, education and salary desired. All answers strictly confidential. Statement of availability required. Address replies to Box 19, % The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

Ryan elected vice president

Paul Ryan

Paul Ryan, former president of the National Refining Company of Cleveland, Ohio, who recently has been serving in an important capacity with the Petroleum Industry War Council, has been elected a vice president of The M. W. Kellogg Company, petroleum and chemical engineers, of Jersey City, New Jersey, and New York.

Ryan will manage a newly instituted consulting service, which is expected to prove of great value to oil refiners in the postwar era. This new service will provide counsel for refiners in the adequate evaluation of the factors of production, refining, transportation, marketing, and finance.

Acquire three companies

Acquisition of three new companies, expanding Dresser Industries, Inc., to 13 members, has been authorized by Dresser directors, President H. N. Mallon announces.

The companies to be acquired are the Day and Night Manufacturing Company of Monrovia, California, the Payne Furnace and Supply Company, Inc., of Beverly Hills, California, and Kobe, Incorporated of Huntington Park, California. The acquisition will be accomplished by an exchange of stock and will be effected about February 1, 1945, if approved by stockholders of the three companies.

Wiley consultant for Big Three

G. L. Wiley

George L. Wiley has joined the Big Three Welding Equipment Company at Houston, Texas, as welding consultant, it is announced.

The company with offices also at Fort Worth, El Paso, Orange, and San Antonio, is the Texas distributor for The Lincoln Electric Company, Cleveland, Ohio, manufacturer of electric arc welding equipment.

Better known in the industry as "Duke," Wiley has been promoting the use of electrict arc welding for the last 26 years. He was the founder of the first Fusion Forum, has held committee chairmanships in both the American Welding Society and the American Society for Metals, and has addressed many societies, universities, and other groups on welding. He was one of the first to undertake the arc welding of oil storage tanks and welded steel construction of buildings.

Heads engineering committee

Lee Flood

H. Lee Flood has been chosen chairman of the engineering committee of the Goldsmith pool, West Texas, succeeding E. H. Griswold, who returns to his activities as an independent operator.

Flood recently has been with the Crane Packing Company, making his headquarters in New Orleans and Houston. Previously he had been with Petroleum Administration for War at Washington, D. C., and prior to that was associate editor of *The Petroleum Engineer*. He will make his headquarters at Midland, Texas.

Army-Navy "E" award

A. Leschen and Sons Rope Company, St. Louis, Missouri, has been given the Army-Navy "E" for high achievement in war production. The award was made December 8.

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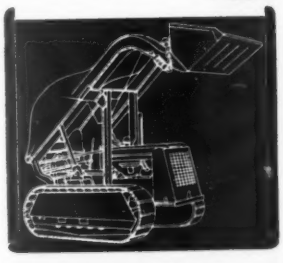
lock in "engagement" or "release" positions, providing positive control during long periods of engagement or disengagement.



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